EXPERIMENTAL STUDY OF STEAM SURFACTANT FLOOD FOR ENHANCING HEAVY OIL RECOVERY AFTER WATERFLOODING

A Thesis

by

DINMUKHAMED M. SUNNATOV

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

May 2010

Major Subject: Petroleum Engineering

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Approved by:

Chair of Committee,	Daulat D. Mamora
Committee Members,	Walter B. Ayers
	Yuefeng Sun
Head of Department,	Stephen A. Holditch

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ABSTRACT

Experimental Study of Steam Surfactant Flood for Enhancing Heavy Oil Recovery after Waterflooding. (May 2010)

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Chair of Advisory Committee: Dr. Daulat D. Mamora

Steam injection with added surface active chemicals is one of general EOR processes aimed to recover residual oil after primary production processes. It has been demonstrated that, after waterflooding, an oil swept area can be increased by steam surfactant flow due to the reduced steam override effect as well as reduced interfacial tension between oil and water in the formation. To investigate the ability to improve recovery of 20.5^{o}API California heavy oil with steam surfactant injection, several experiments with a one-dimensional model were performed.

Two experimental models with similar porous media, fluids, chemicals, as well as injection and production conditions, were applied. The first series of experiments were carried out in a vertical cylindrical injection cell with dimensions of 7.4 cm x 67 cm. The second part of experiment was conducted using a horizontal tube model with dimensions of 3.5 cm x 110.5 cm. The horizontal model with a smaller diameter than the vertical injection cell is less subject to channel formation and is therefore more

applicable for the laboratory scale modeling of the one-dimensional steam injection process.

Nonionic surfactant Triton X-100 was coinjected into the steam flow. For both series of experimental work with vertical and horizontal injection cells, the concentration of Triton X-100 surfactant solution used was chosen 3.0 wt%. The injection rates were set to inject the same 0.8 pore volumes of steam for the vertical model and 1.8 pore volumes of steam for horizontal model.

The steam was injected at superheated conditions of 200^{o}C and pressure of 100 psig. The liquid produced from the separator was sampled periodically and treated to determine oilcut and produced oil properties. The interfacial tension (IFT) of the produced oil and water were measured with an IFT meter and compared to that for the original oil. The experimental study demonstrated that the average incremental oil recovery with steam surfactant flood is 7 % of the original oil-in-place above that with pure steam injection.

DEDICATION

This thesis is dedicated to my parents, family and my friends who supported me during my work at this project at Texas A&M University. I warmly appreciate their credence, love, and support.

The special appreciation I would like to express to Assel Aitkaliyeva whose warm encouragement and great help made the completion of this challenging research possible.

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I would like to express my heartfelt appreciation to my family members for their trust, support and patience during the whole time of my study.

NOMENCLATURE

EOR	enhanced oil recovery
SF	surfactant flood
SSF	steam surfactant flood
IFT	interfacial tension
OIP	oil-in-place
ROIP	residual oil-in-place
LAAS	lineal ionic-alkyl-aryl sulfonate
SASF	surfactant alkaline steam flood
W/O	water-oil
O/W	oil–water
PV	pore volume

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CHAPTER I

INTRODUCTION

1.1. Overview

Heavy crude oils comprise approximately 15% of the world oil reserves[1]. The common characteristics for heavy oils are low API gravities and high viscosities. Heavy oil is usually found in high-permeability and high-porosity, unconsolidated sand formations. At reservoir conditions heavy oil has a limited mobility due to its high viscosity, which ranges from 50 to 50,000 cP, and its density values, which are similar to that of water[2].

The economical efficiency of existing technologies is sufficient for the recovery of only about one third of known oil reservoirs. Heavy oils are usually considered as unconventional petroleum resources, since unconventional methods are applied for its production. Enhanced oil recovery (EOR) processes were not widely implemented until recently, due to the low oil prices. Nowadays, with higher oil prices and increasing world oil demand, the interest in EOR methods has increased significantly[3].

Several types of EOR processes may be used for light and heavy oil reservoirs. The main EOR categories are as follows.

- Thermal - hot water injection, steam injection, in-situ combustion;
- Chemical - alkaline flood, surfactant flood, polymer flood; and
- Gas Injection - CO_2 miscible and immiscible injection, hydrocarbon miscible and immiscible injection, and nitrogen injection.

The thesis follows the style of *Society of Petroleum Engineers Journal*.

To recover additional heavy oil after primary production processes (i.e. cold production), steam injection is widely used to displace unswept oil towards the production wells. Although the steam flood process is able to provide high recovery of the unswept oil-in-place (OIP), it suffers from possible gravity override and steam channeling through the high permeability zones. As a result of channeling, the depleted zones receive the bulk of the injected steam, whereas the less permeable oil saturated zones remain unswept by steam. To increase steam injection efficiency by reducing the effect of channeling, and to reduce residual oil saturation, various steam-surfactant injection technologies have been studied since as early as the 1970s[4].

Surfactant flooding leads to the reduction of oil-water interfacial tension (IFT) and to the reduction of capillary forces which may trap oil in the formation pores[5]. Surfactant flood is a process of injecting surface-active chemicals, usually along with water. Molecules of surfactants are both hydrophobic and hydrophilic, which are able to form stable configurations in oil-water interface[6]. There are several possible mechanisms by which the injected surfactant can enhance oil recovery, such as (a) emulsification and entrainment of oil droplets, (b) wettability reversal, and (c) foaming[2-8].

The concentration of surfactants used for the chemical flood is usually 2-5 wt% (water solution)[9]. The technology of adding alkaline to the surfactant flood allows reducing the concentration of expensive surfactants. The role of alkali in this case is that it can: (a) reduce the adsorption of the surfactant by the formation and sequestration of divalent ions, (b) form in-situ a soap from naphthenic acid of the crude oil, and (c) alter formation wettability to either water wet or oil wet condition.

Surfactants can be classified according to the ionic nature of the head group as anionic, cationic, nonionic and zwitterionic. The surfactant used for this experimental study is Triton X-100, a nonionic surfactant, manufactured by J.T. Baker Chemical Company. Nonionic surfactants dissolve in aqueous solutions through hydrogen bonding between the water molecules and the oxyethylenic part of the surfactant[10]. These interactions maintain the molecule in the solution up to the cloud point temperature. The increase of salinity of the solution decreases the cloud point temperature of the surfactant[5].

Natural imbibition is another production mechanism that should be considered. During the imbibition process, the decrease of IFT increases the oil production rate[11]. The temperature increase in the imbibition process with surfactants may result in increased total oil recovery.

1.2. Research Objectives

The main objective of my research was to investigate experimentally the effect of steam surfactant injection on enhancing oil production after waterflood for heavy oil. To achieve this objective I accomplished the following tasks:

1. I quantified experimentally the incremental gain in oil recovery with steam-surfactant injection compared to that with pure steam injection.
2. I analyzed the influence of steam injection with the addition of nonionic surfactant on the oil viscosity and oil density.

The experiments were conducted at the Ramey Laboratory with a one-dimensional sandpack cell. This model would not fully reproduce the process of steam surfactant injection as accurately as a three-dimensional model; nevertheless, enough information was obtained to understand the process.

The experimental work consisted of five runs with co-injection of surfactants using various concentrations. The coinjection of surfactant solution to the steam flow did not affect the total recovery of remaining oil in case of laboratory scale experiments. For my experiments I used intermediate oil from California (with gravity of 20.5^{o}API). I used a nonionic surfactant Triton X-100 ($C_{14}H_{22}O(C_2H_4O)_n$), with a concentration of 3.0 wt% for each run.

After the series of experiments were completed, the experimental results were compared in terms of oil recovery under steam injection with and without the addition of surfactant.

CHAPTER II

LITERATURE REVIEW

Some experimental studies of the effect of surfactants on improving steam flood process were conducted in the 1970s. The earlier investigations were aimed at understanding mechanisms involved in steam surfactant flood and to find the criteria for the chemical substances which could be applied for this process. First experiments were set for studying static properties of surfactants, dynamic displacement of steam with surfactants added[4]. Lately, the experimental work was carried out for models in the presence of oil at residual saturation. To enhance this EOR technique, the injection method, concentration, amount and type of surfactant, and steam quality shall be optimized.

Al-Khafai *et al*. (1982) conducted two experiments for investigating commercial chemicals at reservoir conditions with steam injected at 400^{o}F and 300-500 psia[12]. To study flow, mobility and heat transfer, a linear model was used. The common problem of this process is the formation of channels and, as a result, steam override. The reason for channels formation is that mobility of displaced fluid is much lower than that of the displacing fluid (steam). Due to the differences in density between steam and oil, steam override occurs. To reduce steam mobility and, in turn, reduce steam override, surface active substances are used as additives with steam. As concluded from this work, steam mobility was significantly reduced in the presence of surface active substances. The average steam saturation in the saturated steam zone increased as the steam zone grew.

Robin (1987) conducted laboratory studies of foamability and foam stability at high temperature and pressure surrounding conditions inherent to steam injection conditions[13]. In heterogeneous reservoirs the breakthrough of the steam can take place in higher permeabilities zones. For steam flooding, the microscopic efficiency is high, while the sweep efficiency may be relatively low. During steam flooding, the effectively swept areas of a reservoir contain low residual saturation of oil. The steam tends to flow to the upper layers of a reservoir and after steam reaches the production well, the swept area is not increasing any longer. The tests of several hydrocarbon chain sulfonates in homogeneous and heterogeneous media demonstrated that the foam can be used to block off the paths.

Hutchinson *et al.* (1992) conducted a study of steam foam mechanisms at residual oil saturations under dynamic conditions[14]. Previous works were conducted either in the absence of oil or at static conditions. The model used was a sandpack saturated with 17^{o}API oil at 12% of residual oil saturation. 100% quality steam was injected at pressure of 70 psi until breakthrough.

As a result of this study, the authors stated that: (a) the injection of slug with consecutive steam and nitrogen injection proved to be more effective in comparison to co-injection of surfactant; (b) the slug size is recommended to be above the minimum for optimal use of surfactant; (c) steam quality is critical for the process high quality of the steam demonstrates more efficiency in the case of slug injection.

The new technology of cyclic steam injection with surfactants was evaluated in Venezuela in 1997. Valera *et al.* (1999) presented results obtained from stimulation of

Bachaquero-01 reservoir new and reentry wells with steam and surfactant[15]. This reservoir in western Venezuela contains about 6,621 MMSTB of 11.7°API oil with viscosity of 635 cps, at 1360 psia and 128°F. The gravity override and steam channeling cause steam flow through a depleted zone bypassing other reserves and as a result reduces production efficiency in steam soak. To improve steam flood Lineal ionic-Alkyl-Aryl Sulfonate (LAAS) was applied for the field test after laboratory tests for plugging capacity, thermal stability, and some other. For these tests wells with certain criteria were selected. The four stage steam-surfactant injection program was worked out. Firstly, steam was injected during two days to clean and stimulate the most perspective sands. Secondly, to block desired areas, steam and surfactant were co-injected. The next stage of injection steam and surfactant was the longest one to achieve the divergent effect in the well. The last stage was a pure steam injection. For the continuous stage the concentrations of surfactants were 0.75 to 0.85 % and 0.35 to 0.45 % for the intermittent phase. The increment greater than 41% in comparison with the steam injection without additives was obtained for 39% of vertical wells.

Shedid *et al.* (2000) studied thermal chemical process to improve oil recovery and to minimize cost of the chemical(s) used[16]. The authors reviewed the earlier studies of steam flooding processes with application of surfactants and alkaline and stated that use of both chemicals solution has not been done before. They proposed that surfactant alkaline steam flood (SASF) process can significantly improve oil recovery from water flooded, steam flooded, and other reservoirs which are not attainable by other EOR methods. The experimental model for sandpack steam and chemical steam injection was

built to test crude oil (East Aghar oil field, Egypt) with 12^{o}API (at room temperature 70^{o}F). The steam injection rate was 1.952 cc/min with pressure drop between the injector and production ports 19.7 psi for SF, and almost 34.3 psi for chemical steam floods. The displacement efficiency (E_D) for steam surfactant flood (SSF) is estimated to be 45.79% which is 12.93% more than for surfactant flood (SF). During this experimental research the efficiency of various chemical steam flood processes were defined and compared to the conventional steam flood. Also, the analysis of displacement efficiency and interfacial tension reduction were measured. The SASF is the most effective process of those studied and requires almost twice as less chemicals at similar conditions.

The same year Shedid *et al.* (2000) presented the second paper in which steam chemical flood efficiency between vertical and horizontal wells processes was made[17]. The experimental model was created and four chemical steam recovery techniques were investigated and compared for two types of wells with the similar oil, brine, porous media, chemicals, steam, and injection/production procedures. Two flooding apparatus were designed to simulate steam chemical injection for vertical and horizontal wells. The flood was carried out through sandpacks with the superheated steam (150^{o}C at pressure of 54.7 psig). Crude oil from East Aghar oil field, Egypt was used for the experiment. The following chemicals were used for the study: (a) surfactant Triton X-100 and (b) NaOH.

The authors concluded that all steam chemical flood runs were much more efficient than pure steam injection, among which SASF provides the highest oil recovery. Also, they concluded that for horizontal wells, all of the chemical steam

processes obtained a higher oil recovery than vertical wells. For my research I am focused on SSF process, and I expect that almost 20% of additional oil can be recovered by SSF for vertical flood after water flood.

Additionally, Bryan *et al.* (2008) studied mechanisms of producing unrecovered heavy oil[18]. It is critical to know the state of the reservoir at the time of injection to understand how heavy oil can be recovered. At the end of waterflooding low mobility ratio between oil and water leads to bypassing the heavy oil and the ability of this oil to flow depends on applied pressure gradients and the permeability of the rock. "A simple reduction in oil-water IFT, similar to mechanisms proposed for conventional oil EOR, *will not* be effective in displacing the oil". Injected chemicals are purposed to improve the mobility ration between oil and water and hence provide a more stable displacement of oil towards production wells.

In reservoir conditions added chemicals are able to form emulsions. Surfactants, due to high oil viscosity in reference to water, will normally create water-oil (W/O) emulsions. W/O emulsion might have higher viscosity than heavy oil, which can cause certain problems related to oil production and transportation. But some EOR application showed that this mechanism could improve heavy oil recovery due to the ability of more viscous water-oil emulsion to displace oil in a more stable fashion. Oil-water (O/W) emulsions can also form under certain conditions with the addition of surfactants and/or alkali mixtures.

CHAPTER III

EXPERIMENTAL APPARATUS AND PROCEDURE

3.1. Apparatus

The experimental equipment for steam surfactant injection used for this work are one-dimensional models used in the Ramey Thermal Recovery Laboratory: a vertical injection cell and a horizontal cell. The apparatus consists of three main parts: a fluid injection system; a fluid production system and a data logger system. The schematic diagram of the system is shown in **Fig. 3.1**. The two types of cells, used for this experiment are shown in **Fig. 3.2**.

3.1.1 Vertical Injection Cell

The vertical injection cell is used to study one-dimensional displacement of oil by an injectant such as steam. For steam injection, the cell is mounted vertically to prevent steam over-ride (and therefore not a one-dimensional displacement). The cell is a vertical stainless steel cylinder of length of 27 inches and internal diameter of 2.9 inches. The cell is capped by a flange at the top. A 3/16-inch thermowell is placed inside the cell along its longitudinal axis. Sand production is prevented by multilayered steel meshes placed at the bottom of the thermowell and lowered to the bottom of the cell. The temperature profiles throughout the cell during the steam flood are monitored by six thermocouples placed inside 1/8-inch tubing that is inserted inside the thermowell (**Fig. 3.3)**.

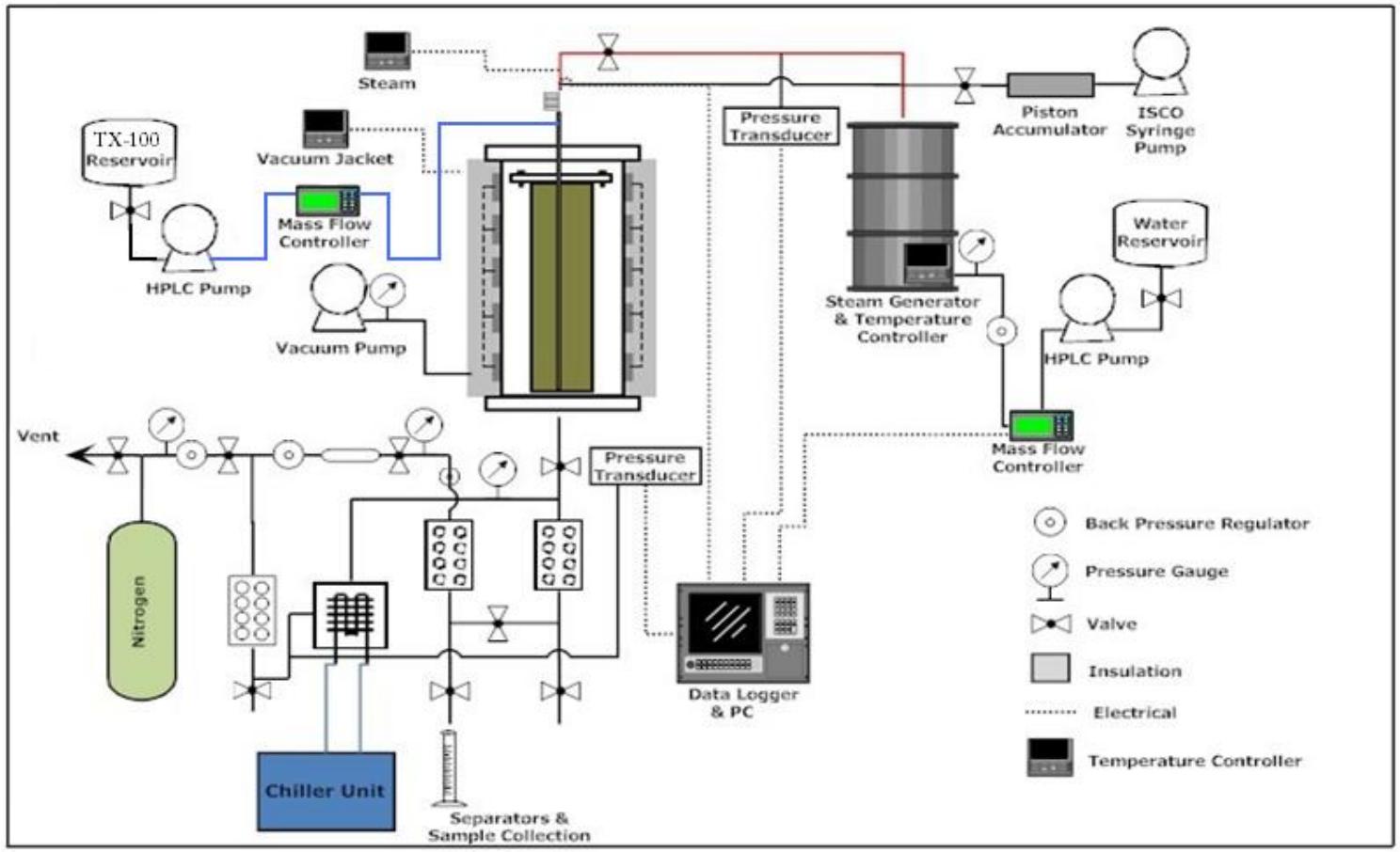

Fig. 3.1 — Schematic diagram of steam injection apparatus (Mohammad A.A., 2008).

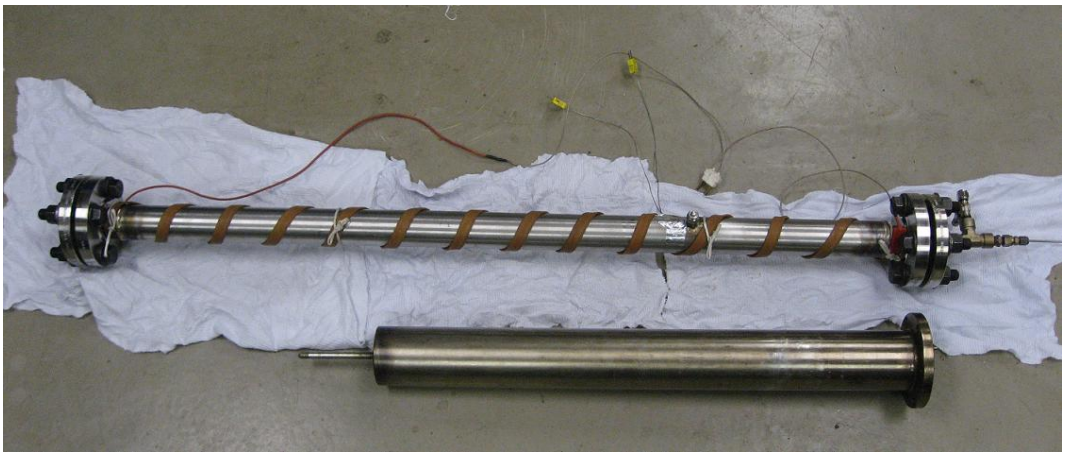

Fig. 3.2 – Horizontal cell (top) and vertical cell (bottom) used for steam-surfactant injection.

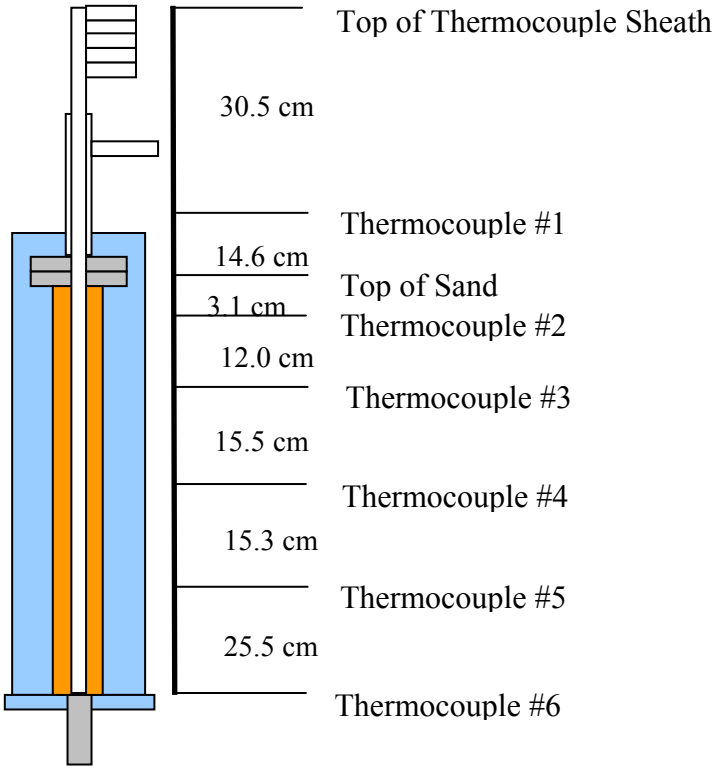

Fig. 3.3 - Schematic diagram of thermocouples in vertical injection cell.

Sand mix - consisting of the desired ratios of sand, water and crude oil – is tamped into the cell. The cell is placed vertically in the vacuum jacket. The annulus between jacket and the cell is evacuated using a vacuum pump. The vacuum minimizes heat loss from the cell during the steam injection runs. The vacuum jacket is fitted out with an electrical heater to heat the cell to the desired reservoir temperature with the aid of a temperature controller.

3.1.2 Horizontal Injection Cell

The horizontal injection cell is a stainless steel cylinder with a length of 43.5 inches and internal diameter of 1-1/16 inches with flanges at both ends. A 1/8-inch thermowell is placed horizontally along the longitudinal axis of the cell. Sand production is prevented by a multilayered steel mesh attached to the bottom of the thermowell and placed at the bottom of the cell. As with the vertical cell, temperature profiles in the cell during steam injection is measured with the help of the six thermocouples placed in the thermowell (**Fig. 3.4)**.

The horizontal cell is integrated with the vacuum jacket. The vacuum in the annulus between the cell and jacket serves to minimize heat loss from the cell during steam injection. Vacuum is obtained with the aid of the vacuum pump connected to the jacket. The outer wall of the vacuum jacket is wrapped with silicon rubber electrical band heater which allows heating of the cell to the desired reservoir temperature. The temperature is regulated by the temperature controller. Both flanges are heated separately to minimize heat loss and to provide more even heating of the cell.

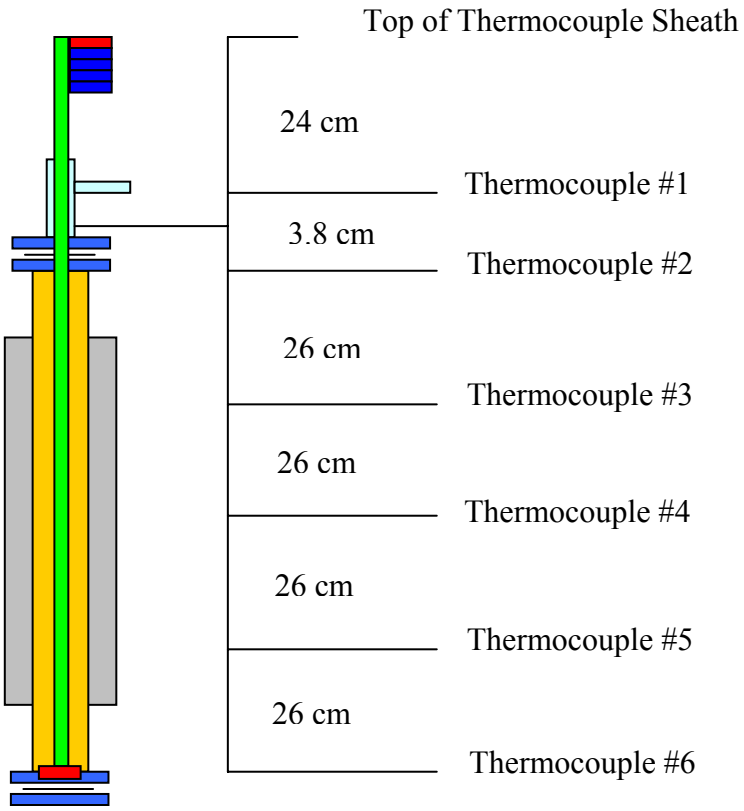

Fig. 3.4 – Schematic diagram of thermocouples in horizontal injection cell.

3.1.3 Fluid Injection System

The fluid injection system consists of the following main components:

(a) High Performance Liquid Chromatography Pumps

Distilled water is supplied from the respective reservoir into the steam generator with one HPLC pump. The second HPLC pump is used for surfactant solution supply from the second reservoir. The flow rates are set for the pumps and monitored by the mass flow meter, readings from which are transferred to the data logger system.

(b) Steam generator

The steam generator is equipped with a temperature controller to generate steam at the required steam temperature and pressure. Heat loss from the from the injection lines is minimized by using electrical heating bands and mineral wool insulation.

(c) Water and surfactant reservoirs

These are 4-liter plastic containers that hold the water and surfactant solution. Each reservoir has a spigot to which is attached 1/8-inch Teflon tubing that is connected to and thus delivering water or surfactant solution to the HPLC pump.

3.1.4 Fluid Production System

The fluid production system consists of one separator and a condenser. The tubing connecting cell and separator is maintained at temperature of about 50^{o}C by means of an electrical band heater. The cell outlet pressure is maintained at a constant pressure of 100 psig by injected nitrogen and controlled with the backpressure regulator. The condenser unit is kept cool with the aid of a water chiller unit. The produced samples are collected at the bottom of the separator in 50 cc graduated tubes.

3.1.5 Data Measurement and Recording System

To measure the process parameters the data logger and personal computer are used. The parameters are recorded every 30 seconds into a data file. The registered parameters are as follows:

- Steam injection pressure,
- Steam injection temperature,
- Outlet cell pressure,
- Cell profile temperature, and
- Water pump rate

A brief description of the main components of the experimental set-up is presented as follows.

HPLC pump: Beckman (model 100A) High Performance Liquid Chromatography pump supplies continuous water to the steam generator.

HPLC pump: An Alcott High Performance Liquid Chromatography pump is used to inject the TX-100 3 wt% surfactant solution.

Steam Generator: Custom made by Texaco with a maximum pressure of 2000 psig and a maximum temperature of 1200°F that provides the necessary steam of the experiments.

Temperature controllers: A dual circuit temperature controller is used to maintain constant temperature of the steam generator. Other temperature controllers were also used to maintain temperatures for the heating jacket and two band heaters used at the inlet and outlet of the injection cell.

Vertical Injection cell: A stainless steel cell that measures 66.5 cm in length and 7.37 cm in diameter. The maximum pressure it is able to withstand is 500 psig at 1000°F.

Horizontal Injection cell: A stainless steel cell that measures 110.5 cm in length and 3.50 cm in diameter. The maximum pressure it is able to withstand is 500 psig at 500°F.

Accumulator: A 150 cc stainless steel, high pressure bottle was used to hold the necessary injection fluids.

Heating jacket: A stainless steel cylinder with five steel band heaters and is well insulated to prevent heat loss. It confines the injection cell and the heaters heat the injection cell to reservoir temperature before steam injection and the annulus is evacuated with a vacuum pump just before steam injection to minimize heat loss during steam injection.

Vacuum pump: used to evacuate the annulus between the injection cell and the heating jacket to minimize heat loss.

Separation and sampling system: used to separate the liquids from the gases and also to sample the production. It consists of high temperature high pressures transparent glass level gauge. The separator in connected to the outlet of the injection cell and the backpressure nitrogen line from the top.

Chiller unit: used to lower the temperature of the condenser between first and third separator.

Data logger: a Hewlett Packard data acquisition unit was used to log the necessary data such as temperature, pressure and injection rate.

The experimental set-ups with vertical and horizontal cells are shown in **Figs. 3.5** and **3.6.**

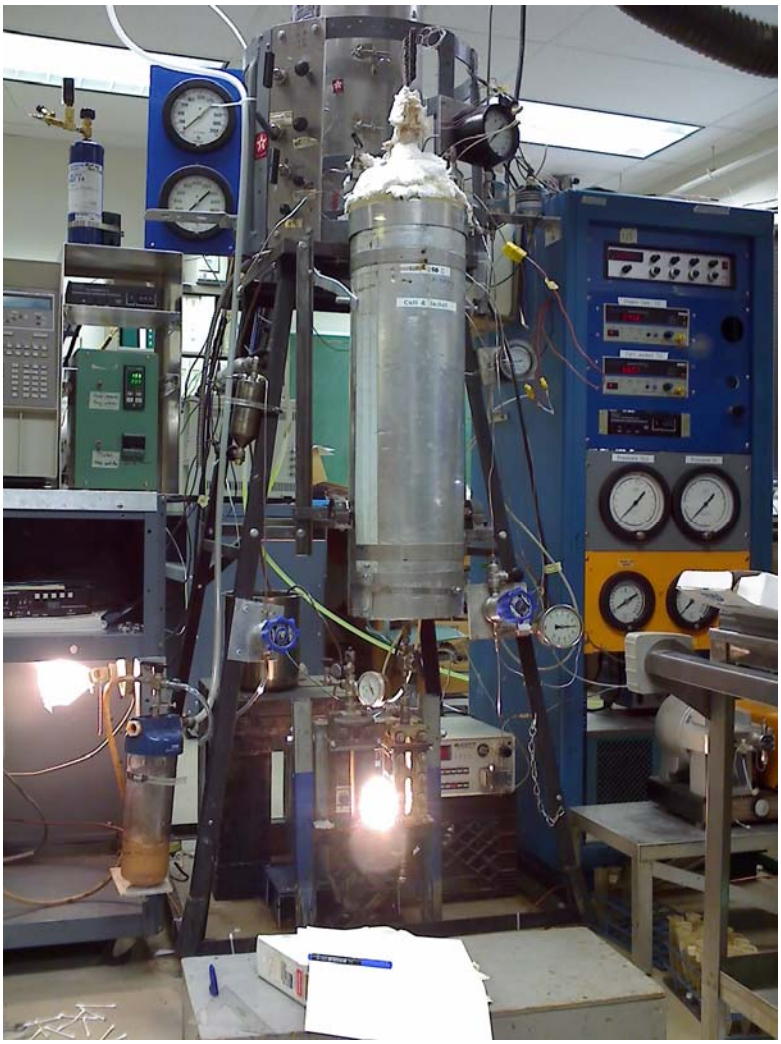

Fig. 3.5 - Experimental set-up with vertical cell.

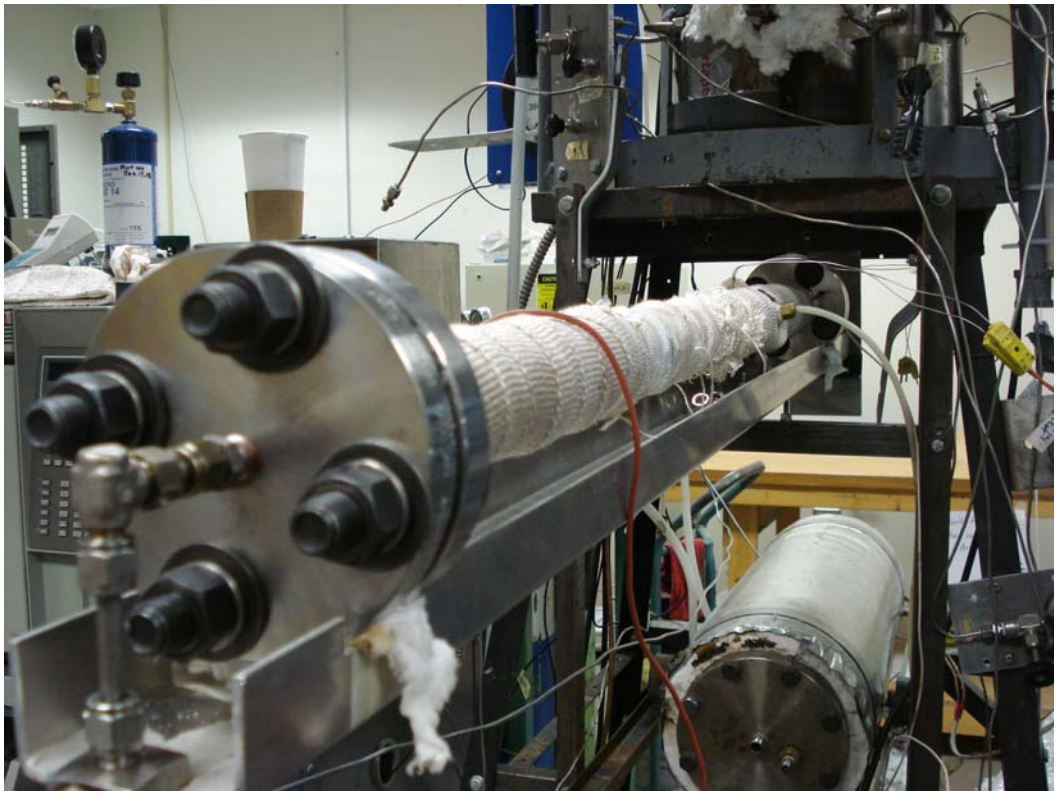

Fig. 3.6 - Experimental set-up with horizontal cell.

3.2. Experimental Procedure

Prior to beginning the experiment, all equipment, including steam generator, injection cell, separators, pumps, water and surfactant reservoirs and all tubing, were thoroughly cleaned to exclude any presence of sand particles and oil traces. Pressure transducers, pumps, pressure gauges and data logger were checked and calibrated.

The second step of the experiment was preparing the oil-sand mixture (sandmix). The crude oil used for this study was 100% dewatered oil. Weight ratio of 100-mesh clean sand, water and oil were preliminary determined. The components were thoroughly mixed in the electrical mixer to produce a uniform mixture. Equal portions

of about 300 cc of the sandmix were placed in the cell followed by tamping until the cell was filled to the top. The weights of the cell - empty and full - were measured. The difference in weights between the empty and full cell enables the calculation of pore volume, fluid and sand volumes, and saturations.

The end caps were then bolted to the flanges of the injection cell. The cell was placed in the vacuum jacket. The cell was connected to the steam generator at the inlet and to the separator at its outlet. Nitrogen was injected into the whole system to pressure test it to 150 psig. The vacuum jacket was tested for leakage by applying vacuum. The temperature of the vacuum jacket was set and left overnight to insure the mixture reached the required reservoir pressure (50^{o}C). The annulus between the cell and jacket was evacuated to insure minimal heat loss during the steam injection. To prevent further heat losses one electrical band heater was wrapped around the tubing connecting the cell inlet and to the outlet of the steam generator. One band heater was also wrapped around the first separator.

One HPLC pump was set to feed water into the steam generator at a constant rate (5.50 $^{cc}/_{min}$ or 4.0 $^{cc}/_{min}$) that is monitored by a mass flowmeter. Injection into the cell begins once the steam generator reaches its preset temperature 200^{o}C and pressure of 100 psig. The steam injection temperature was maintained by using a temperature controller. Production pressure at the cell outlet was controlled by nitrogen gas supplied through a backpressure regulator.

The second HPLC pump was used for the surfactant injection solution. The injection rate was set at a constant rate of 2.5 $^{cc}/_{min}$ or 1.0 cc/min. Surfactant solution (3.0 wt%) was injected directly into the cell with the steam.

Periodic sampling was carried out from the separator. The samples were centrifuged for 35 minutes at 2000 rpm to insure separation of oil and water for proper measurement of production volumes. (The oil production was divided into two equal fractions, one for the first half of the production and the other for the remaining part of the production.) Oil density and viscosity for two production samples were measured using an Anton Parr DMA 4100 density meter and a Brookfield rheometer.

Water rate, injection pressure, injection temperature, production pressure and cell temperature profile were recorded by the data logger system. The data logger system records data every 30 second into the file. The data is displayed real time on the computer display to assist in monitoring experimental conditions during the run.

CHAPTER IV

RESULTS AND DISCUSSION

4.1. General Experimental Parameters

Several experiments were performed to study the effect of surfactant on heavy oil recovery during steam surfactant injection (SSI). Runs using the 20.5 California oil with vertical and horizontal injection cells were made. The initial experimental conditions for all runs were the same and are presented in **Table 4.1**.

Table 4.1 - Experimental conditions for steam and steam surfactant injection.

Parameter	Value	Units	Notes
Cell temperature	50	^{o}C	
Steam injection rate (vertical)	5.5	cc/min	
Steam injection rate (horizontal)	4.0	cc/min	
Steam injection temperature	200	^{o}C	Superheated temperature
Production pressure	100	psia	
Oil saturation	29 - 32	%	Measured for the sandpack
Time for one run	180	min	May vary for all runs

The composition (in wt% of sand, water, and oil) of the sand mixture was kept about the same for all experimental runs. The properties of the mixture inside the

injection cell for all runs are shown in **Table 4.2**. **Appendixes A** and **B** show calculations related to porosity and fluid saturations of the sandpack mixture.

Table 4.2 - Injection cell mixtures for run 1 through run 6.

	Vertical cell		Horizontal cell			
	Run 1 Pure steam	Run 2 3.0 wt% surfactant	Run 3 Pure steam	Run 4 Pure steam	Run 5 3.0 wt% surfactant	Run 6 Pure steam
Sand, g	1640.12	1646.17	658.68	665.91	661.95	663.71
Water, g	223.42	224.24	72.73	73.53	73.09	73.28
Oil, g	375.09	386.7	124.59	126.01	125.26	125.60
S_o, %	28.65	29.67	31.64	32.59	32.07	32.30
S_w, %	17.06	17.21	18.47	19.02	18.71	18.85
S_g, %	54.29	53.13	49.90	48.39	49.21	48.85

In this chapter all runs will be reviewed in two cases (for vertical and horizontal models) and compared between the runs within each case group. The experimental data will be presented referencing to each case as follows:

- Temperature profile inside the injection cell
- Injection, production, and differential pressures profile
- Oil and water production rates
- Oil and water cumulative production

- Oil cumulative recovery and oil content in product
- Oil viscosity and density

4.2. Case 1: Run 1 – Conventional Pure Steam Injection in Vertical Cell

The first run for the vertical model is aimed to experimentally determine the maximum possible oil production with the pure steam injection with no additives. The steam was injected at the rate of 5.5 cc/min; the total injected steam volume was equal to 0.8 PV of water injected to steam generator.

The temperature profile is presented in **Fig. 4.1**.

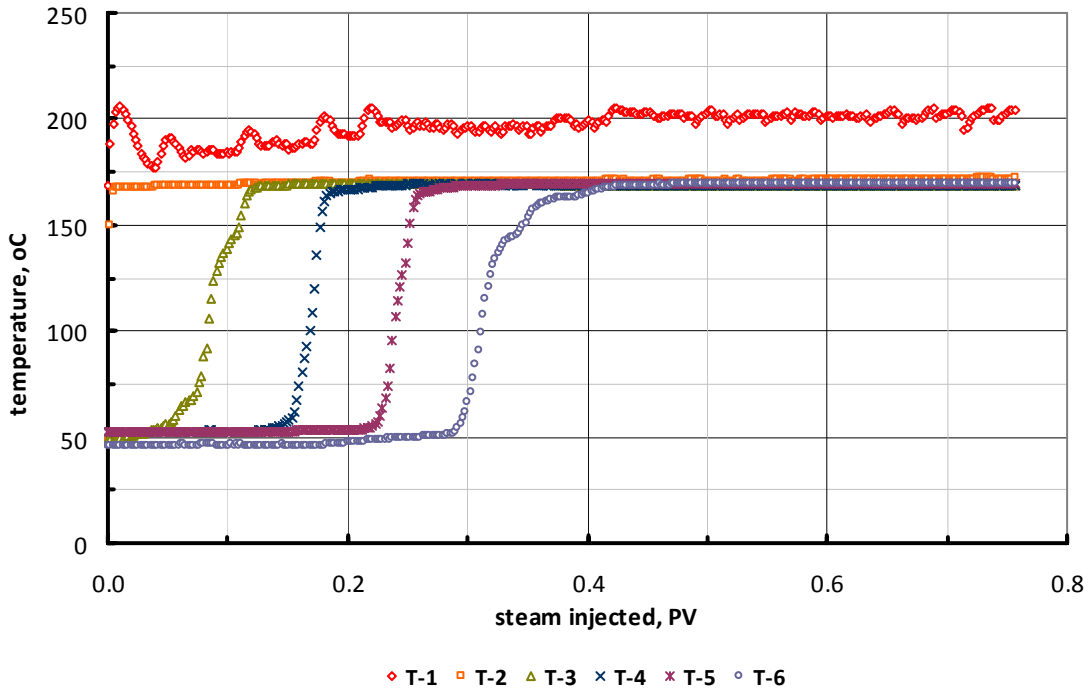

Fig. 4.1- Temperature profile versus volume of steam injected (PV fraction) for run 1 in vertical cell.

As we can observe from Fig. 4.1, a constant temperature throughout the cell was achieved when 0.52 PV of steam were injected, which means that the steam front reached the production end of the cell at the 123rd minute of the injection. The production was stopped at 180th minute, when 0.76 PV of steam were injected.

The injection, production and injection-production differential pressure profiles for this run are presented in **Fig. 4.2.**

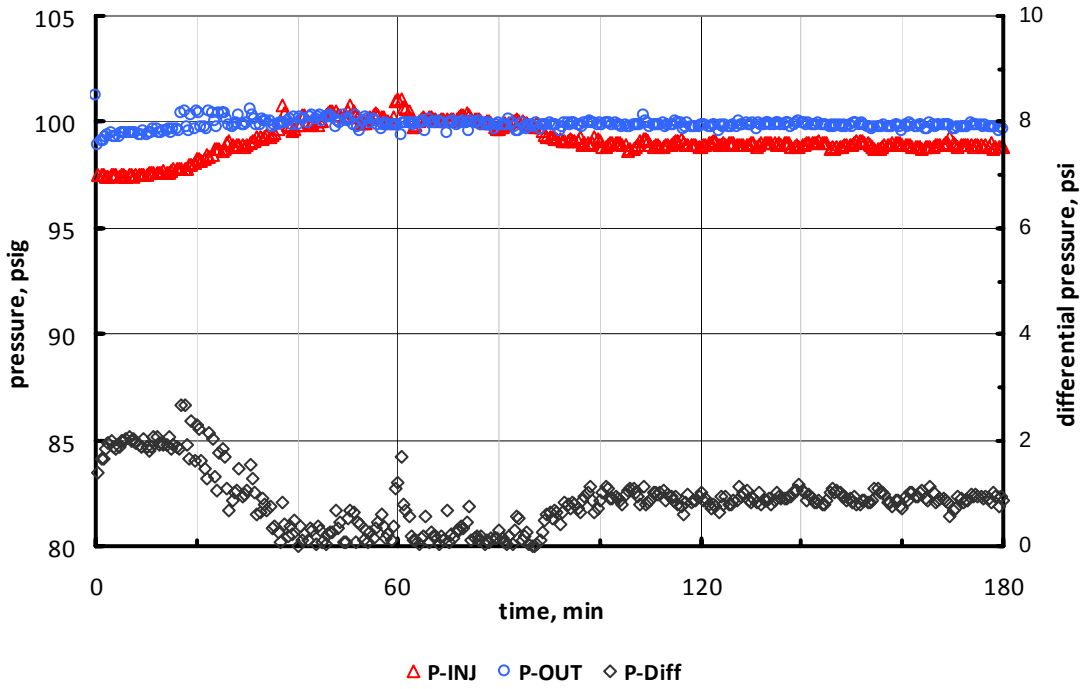

Fig. 4.2 – Injection, production and pressure differential profiles for run 1 in vertical cell.

As shown in the pressure profile, the outlet pressure is maintained at a constant pressure of approximately 100 psig. It is obvious from the figure above that the injection pressure change is about 2 psi only. This small difference between injection and

production pressure is indicative of moderate amount of oil being displaced by the steam. The reason for this occurrence can be a high porosity inside the cell (approximately 44%). The main driving force in this case is gravity, which results in low efficiency of oil displacement due in part to steam channeling as observed when the sandpack was examined after the run.

The oil and water production rate profiles are shown at **Figs. 4.3** and **4.4**. As can be seen from the profiles, the maximum oil production rate of 5.55 cc/min was at the end of the steam front breakthrough. The maximum water production rate of 12.0 cc/min was registered at the 57th minute of the injection (0.33 PV of steam injected); and the decrease of water production rate is observed at the time of steam breakthrough.

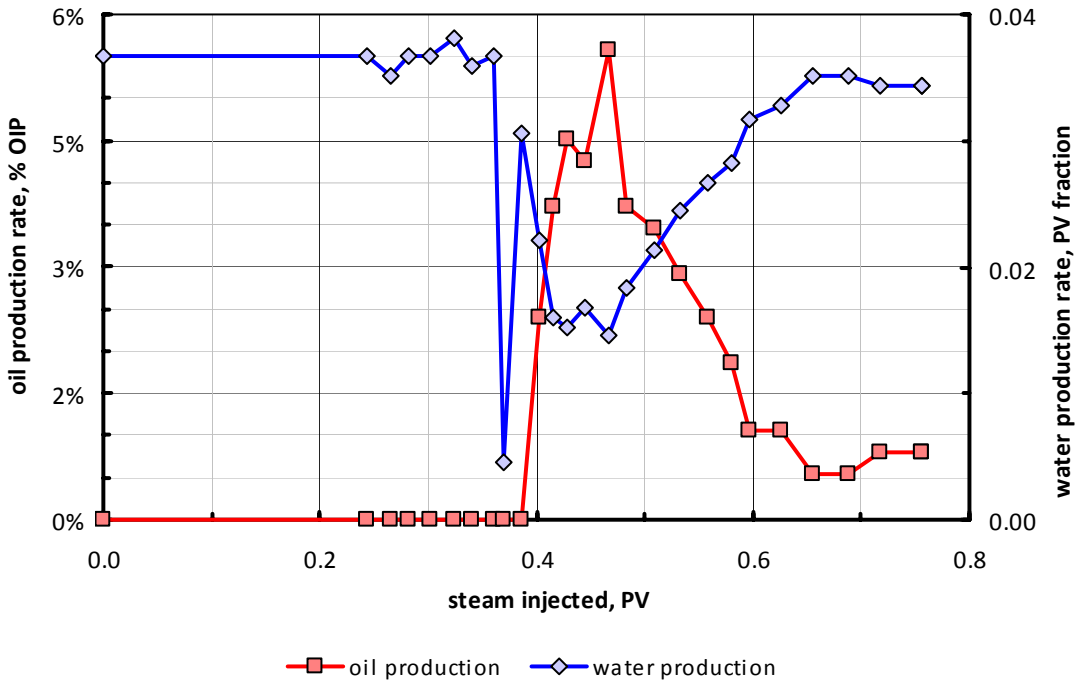

Fig. 4.3 – Oil and water production versus steam injection (PV) for run 1 in vertical cell.

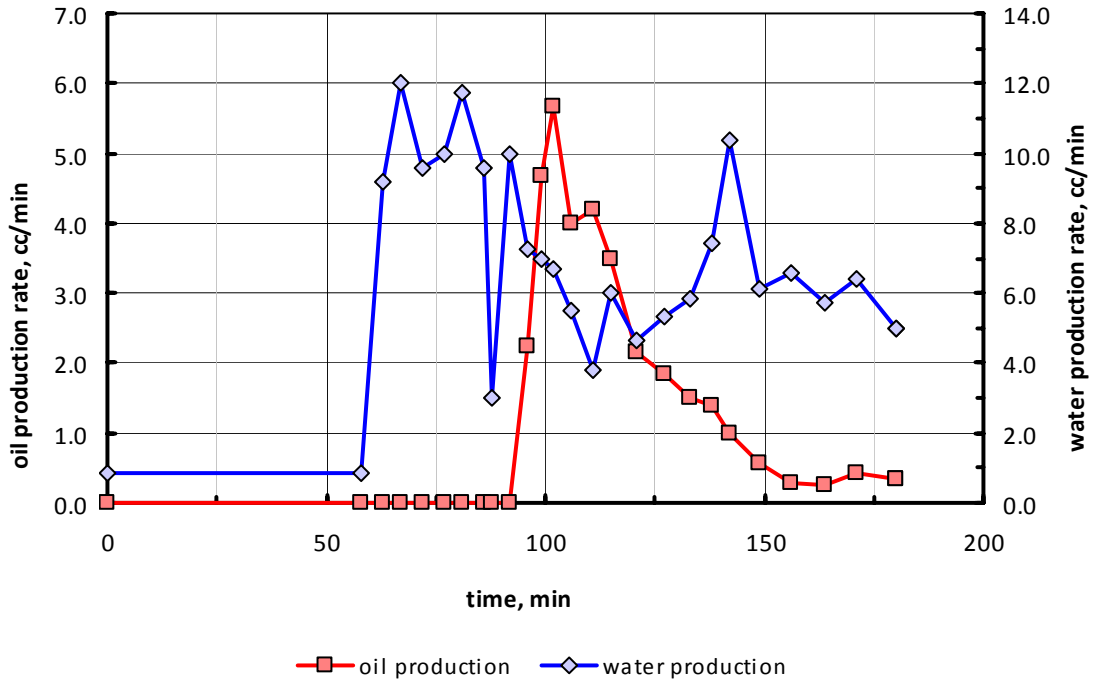

Fig. 4.4 – Oil and water production versus time for run 1 in vertical cell.

Fig. 4.5 presents cumulative oil and water recovery versus pore volume steam injected. For this case, 39.6% of oil-in-place (OIP) was produced; the volume of water produced is equal to 0.70 PV.

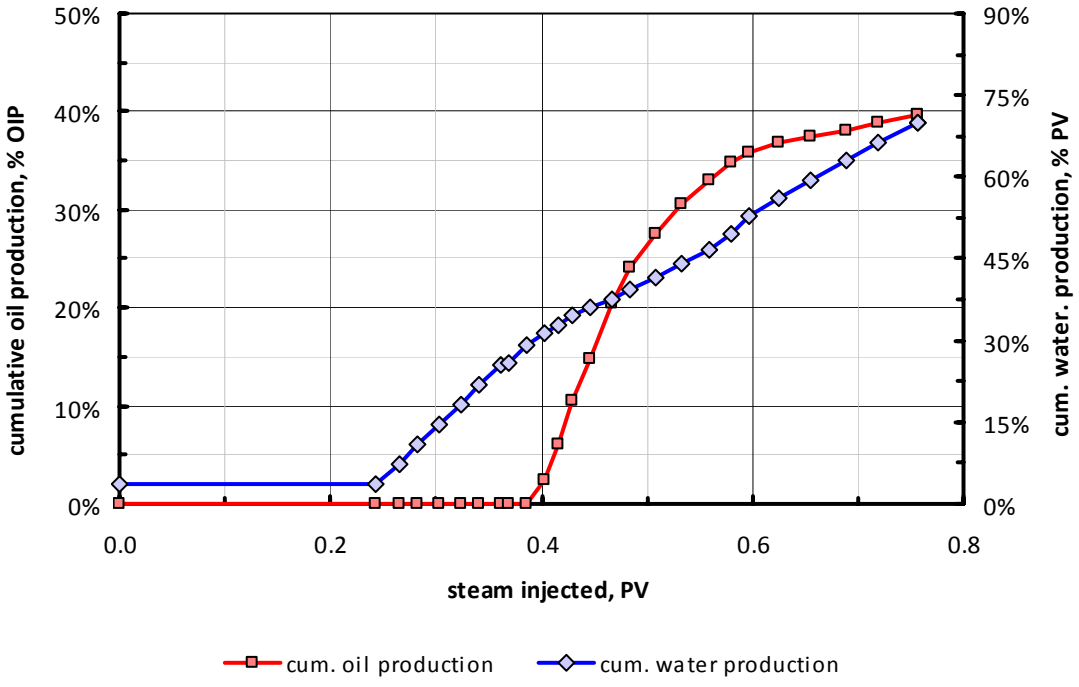

Fig. 4.5 – Oil and water cumulative production versus steam injected (PV) for run 1 in vertical cell.

The measured density and viscosity values for the samplers taken are shown in **Table 4.3**.

Table 4. 3 – Density and viscosity for case 1 run 1 in vertical cell.

Time, min	Density, g/cc	Gravity, ^{o}API	Viscosity, cp	Steam Injected, PV
0	0.9336	19.12	497	0.00
99.0	0.9061	23.65	102	0.42
111.0	0.8985	24.95	87.7	0.47
127.0	0.8673	30.51	68.9	0.53
142.0	0.8339	36.91	40.6	0.60
171.0	0.6775	75.11	13.4	0.72

4.3. Case 1: Run 2 – Steam Injection with 3.0 wt% solution of Surfactant TX-100 in Horizontal Cell

The second run for the case with the vertical cell is aimed to experimentally determine the maximum possible oil production with 3.0 wt% of surfactant solution coinjected into the steam flow. The steam was injected at the rate of 5.5 cc/min, the injection rate of the surfactant solution was set at 2.5 cc/min. To compare this run with the previous one, the process was stopped after the volume of the injected steam achieved 0.8 PV of water injected to steam generator.

The temperature profile for the second run is presented in **Fig. 4.6**.

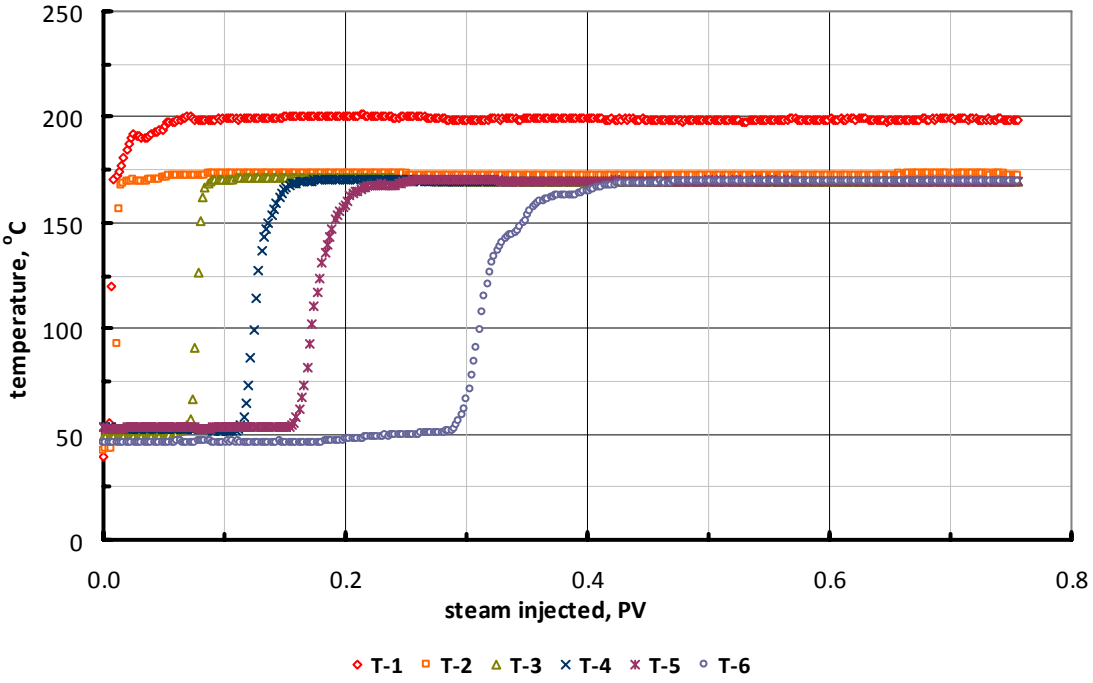

Fig. 4.6 - Temperature profile versus volume of steam injected (PV fraction) for run 2 in vertical cell.

As we can observe from the chart above, the constant temperature was achieved when 0.42 PV of steam were injected, which means that the steam front reached the production end of the cell at the 100th minute of the injection. The production was stopped at 180th minute, when 0.76 PV of steam was injected.

The injection, production and pressure differential profiles for this run are presented in **Fig. 4.7.**

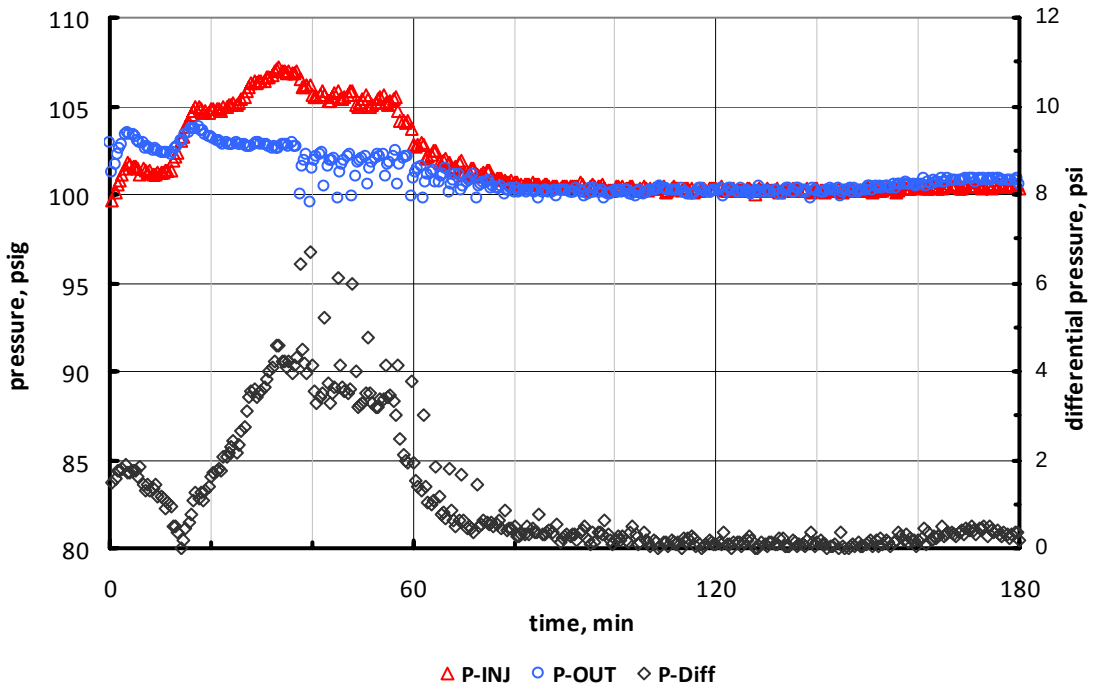

Fig. 4.7 – Injection, production and pressure differential for run 1 in vertical cell.

From the pressure profile above, the outlet pressure is maintained at a constant pressure of approximately 100 psig. The pressure differential is more noticeable compared to the base run, and is evidence of the action of the injected surfactant. Nevertheless, the pressure drop is about 4 psi, which can scarcely be considered as an evidence of significant improved oil displacement.

The oil and water production rates profiles are presented at **Figs. 4.8** and **4.9**. As can be seen from the profiles, the maximum oil production rate of 7.3 cc/min was at the end of the steam front breakthrough. The maximum water production rate of 12.0 cc/min was registered at the 67th minute of the injection (0.26 PV of steam injected); and the decrease of water production rate is observed at the time of steam breakthrough.

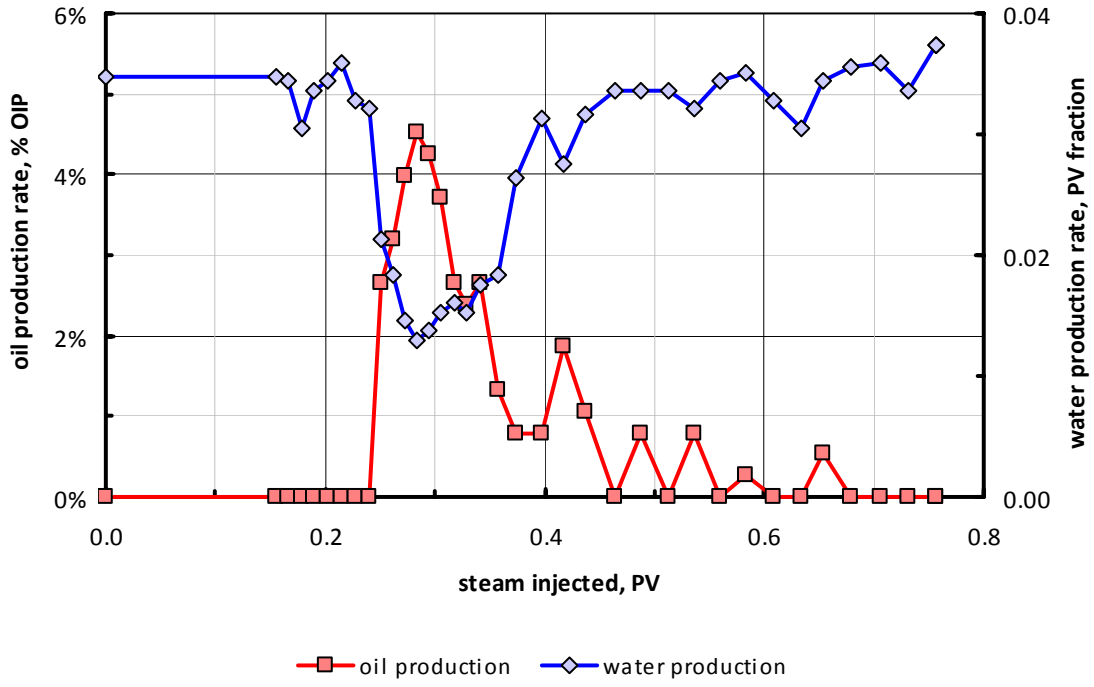

Fig. 4.8 – Oil and water production versus steam injection (PV) for run 2 in vertical cell.

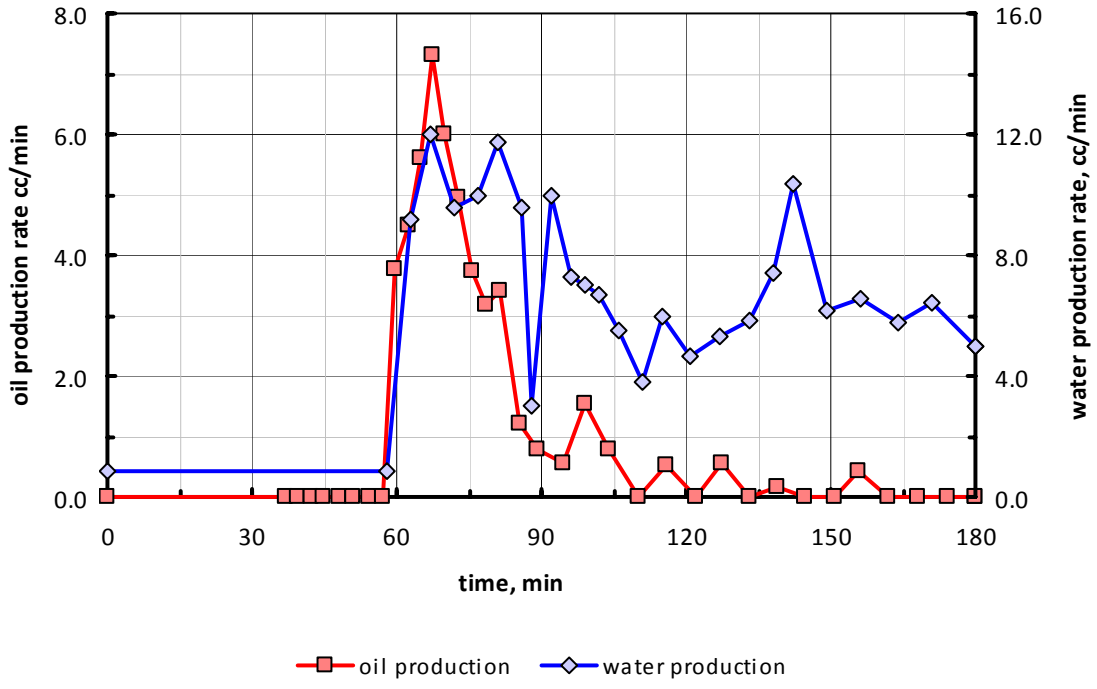

Fig. 4. 9 – Oil and water production versus time for run 2 in vertical cell.

Fig. 4.10 presents cumulative oil and water recovery versus pore volume steam injected. For this case, 38.3% of OIP was produced; the volume of water produced is equal to 0.70 PV.

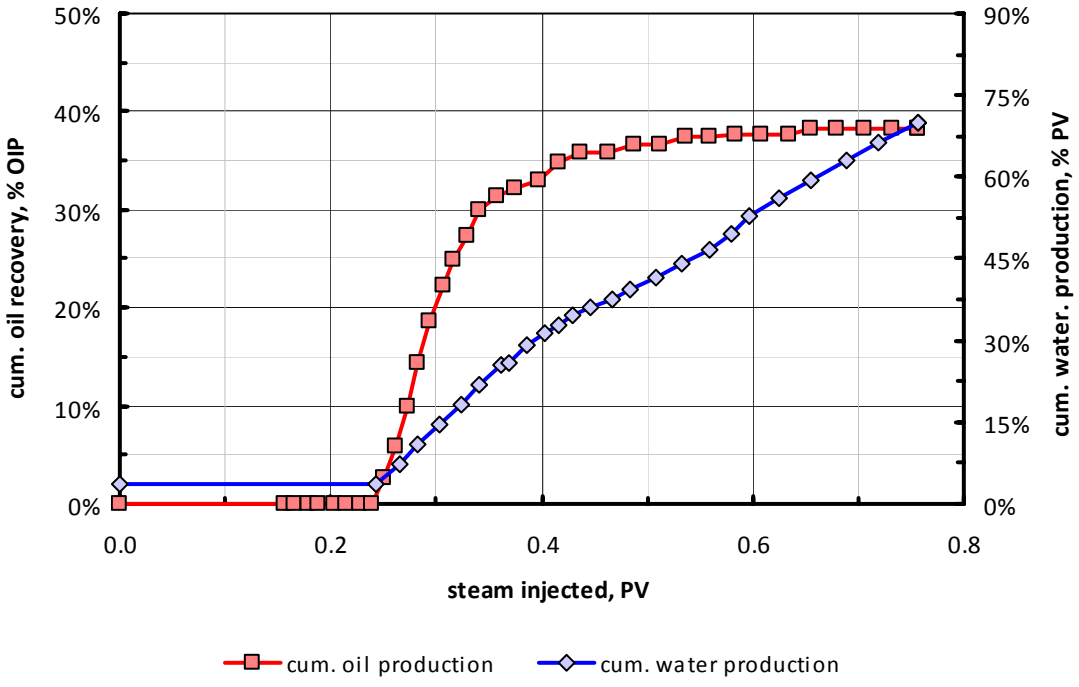

Fig. 4.10 – Oil and water cumulative production versus steam injected (PV) for run 2 in vertical cell.

Figures 4.11 and **4.12** are the comparison of density and viscosity of the oilcut from the first case for steam injection with and without surfactant coinjection:

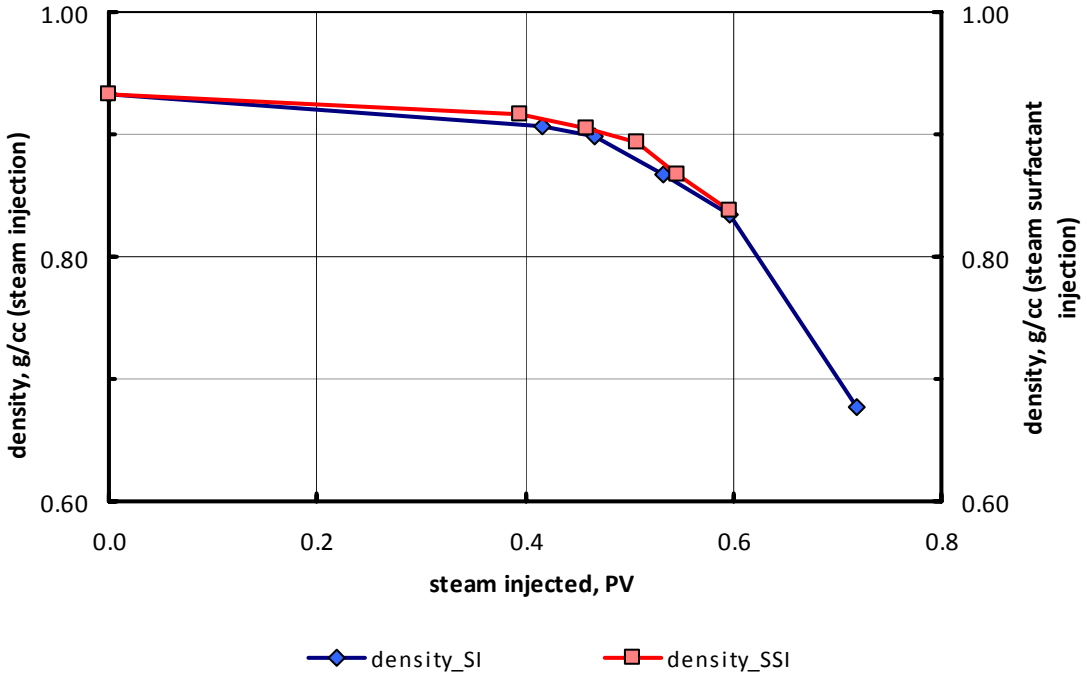

Fig. 4.11 – Oil density change versus steam injected (PV) for runs 1 and 2 in vertical cell.

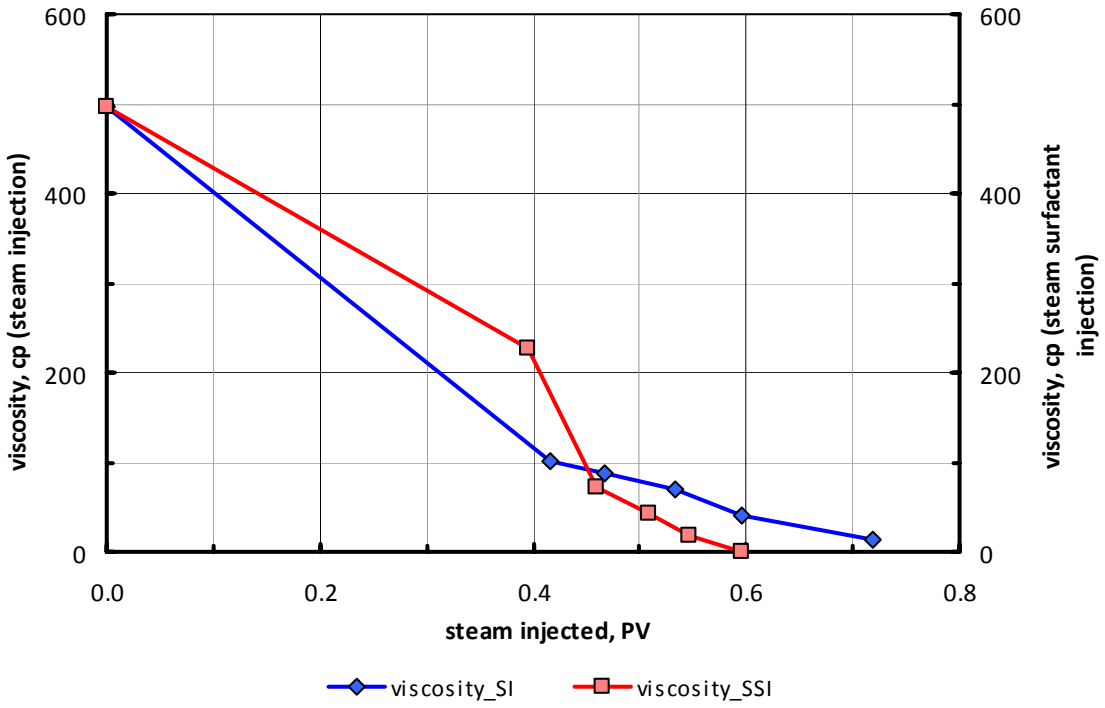

Fig. 4.12 – Oil viscosity change versus steam injected (PV) for runs 1 and 2 in vertical cell.

The measured density and viscosity values for the samples taken are shown in **Table 4.4**:

Table 4. 4 – Density and viscosity for case 1 run 2 in vertical cell.

Time, min	Density, g/cc	Gravity, ^{o}API	Viscosity, cp	Steam Injected, PV
0	0.9336	19.12	497	0
59.7	0.9170	21.83	226	0.39
67.3	0.9043	23.95	72.7	0.46
75.5	0.8932	25.87	42.6	0.51
81.3	0.8673	30.51	17	0.55
99.2	0.8375	36.56	1	0.60

Oil recoveries in runs 1 (pure steam) and 2 (steam plus 3.0 wt% surfactant) are 39.6% and 38.3% of OIP. Thus, adding surfactant solution to steam injection appeared not to provide any additional oil recovery. The change of temperature and pressure are practically identical in both runs. The density of oilcuts is similar in both runs. The tendency of viscosity for the second run to decrease rapidly can be explained by the presence of the surfactant in the oil samples.

From the result presented above, it is obvious that vertical injection cell with its dimensions cannot be used for this experiment. A new horizontal injection cell with smaller diameter and increased length was therefore built. The following sections will describe the results obtained with the experiments held in horizontal cell.

4.4. Case 2: Runs 3 and 4 – Conventional Pure Steam Injection in Horizontal Cell

The first run for the new horizontal model is the pure steam injection with no additives. The steam was injected at the rate of 4.0 cc/min, the total injected steam volume is equal to 1.85 PV.

The temperature profile is presented in **Fig. 4.13**.

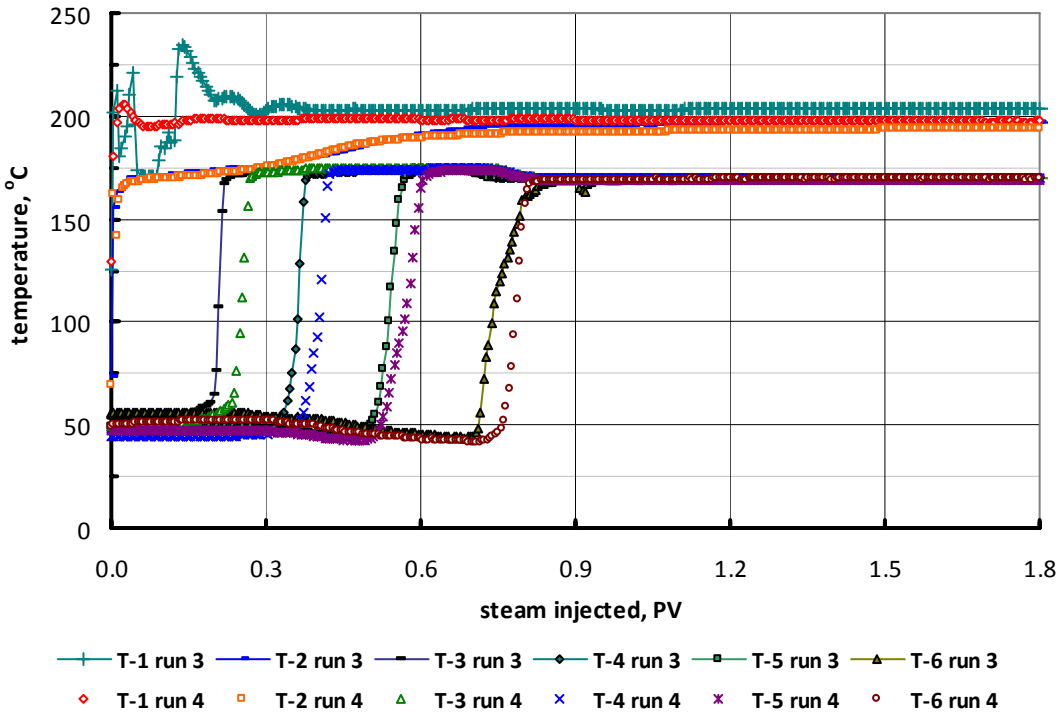

Fig. 4. 13 – Temperature profile versus volume of steam injected (PV fraction) for runs 3 and 4 in horizontal cell.

As we can observe from Fig. 4.13, the constant temperature throughout the cell was achieved when 0.8 PV of steam were injected, which means that steam front reached the production end of the cell at the 81st minute of the injection.

The injection, production and differential pressure profile for this run is presented in **Fig. 4.14**.

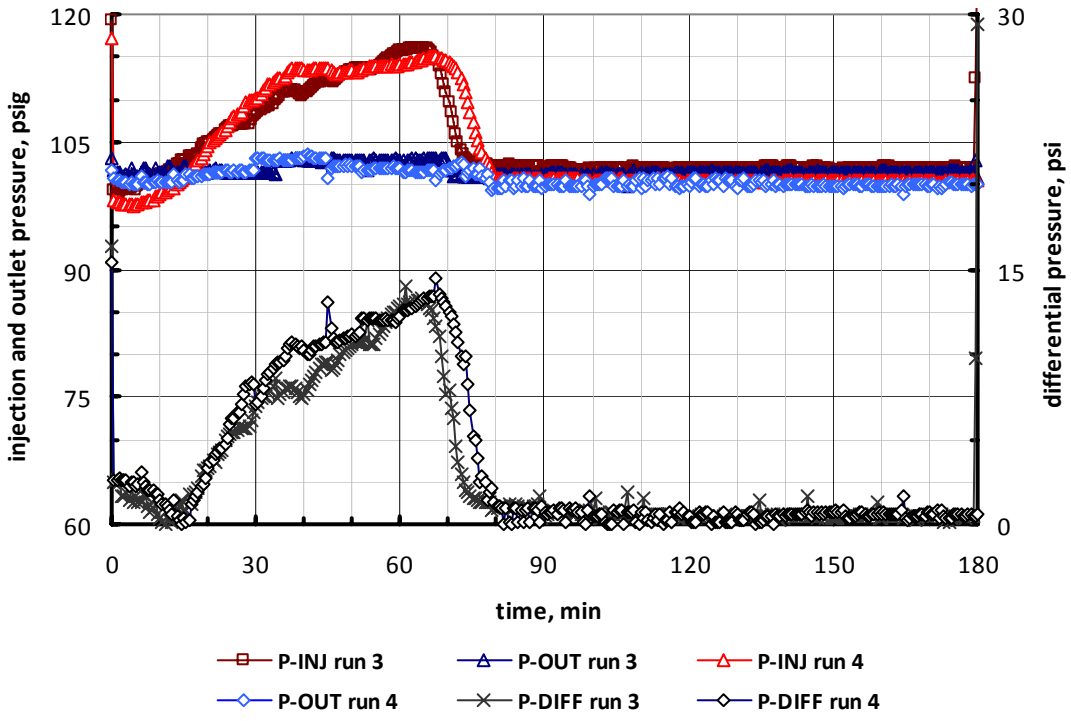

Fig. 4.14 – Injection, production and differential pressure profiles for case 2 runs 3 and 4 in horizontal cell.

As shown in the pressure profile, the outlet pressure is maintained at a constant outlet pressure of approximately 100 psig and while the injection pressure increases up

to the highest value of 115 psig. The tendency of injection pressure to rise is due the development and movement of the oil bank in the cell. Pressure decreases to its minimum value of 100 psi when the oil bank is produced from the cell.

The oil and water production rate profiles are shown at **Figs. 4.15** and **4.16**. As can be seen from the profiles, the maximum oil production rate of 2.36 cc/min was at the end of the steam front breakthrough. The maximum water production rate of 6.57 cc/min was registered at the 52nd minute of the injection (0.54 PV of steam injected); and the decrease of water production rate is observed at the time of steam breakthrough.

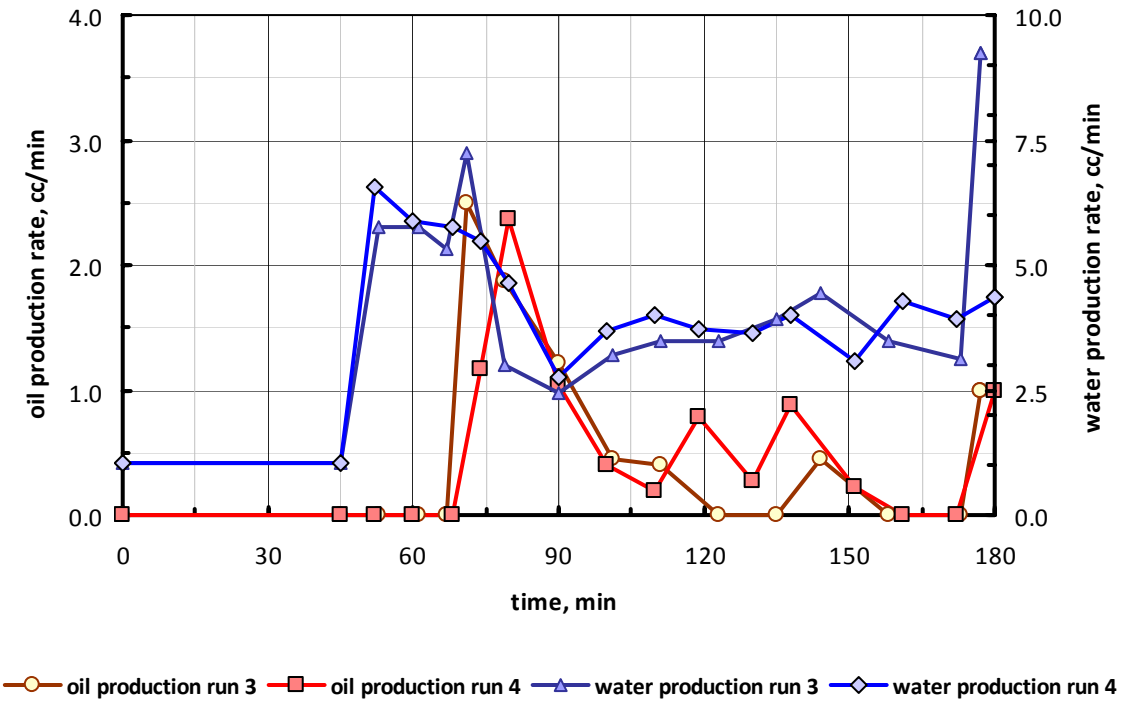

Fig. 4.15 – Oil and water production vs. time for runs 3 and 4 in horizontal cell.

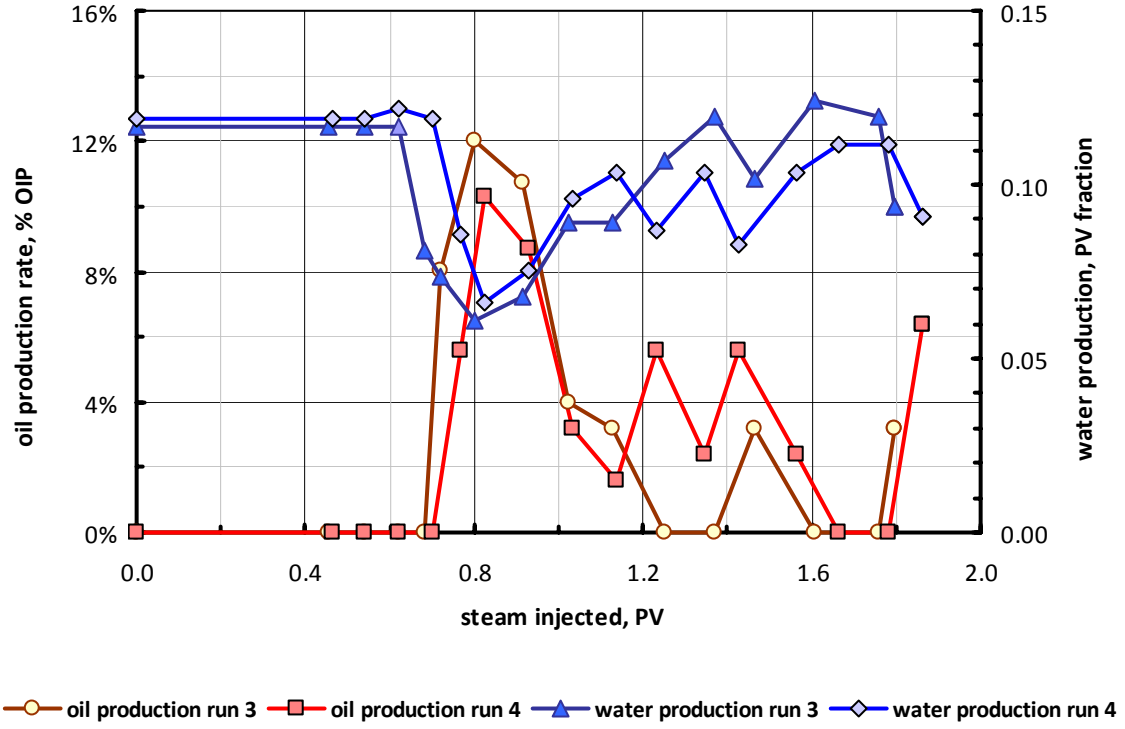

Fig. 4.16 – Oil and water production versus steam injection (PV) for runs 3 and 4 in horizontal cell.

Fig. 4.17 presents cumulative oil and water recovery versus pore volume steam injected. For this case, 44.4% of OIP and 51.6% OIP were produced for runs 3 and 4, correspondingly; the volume of water produced is equal to 1.5 and 1.6 PV, correspondingly.

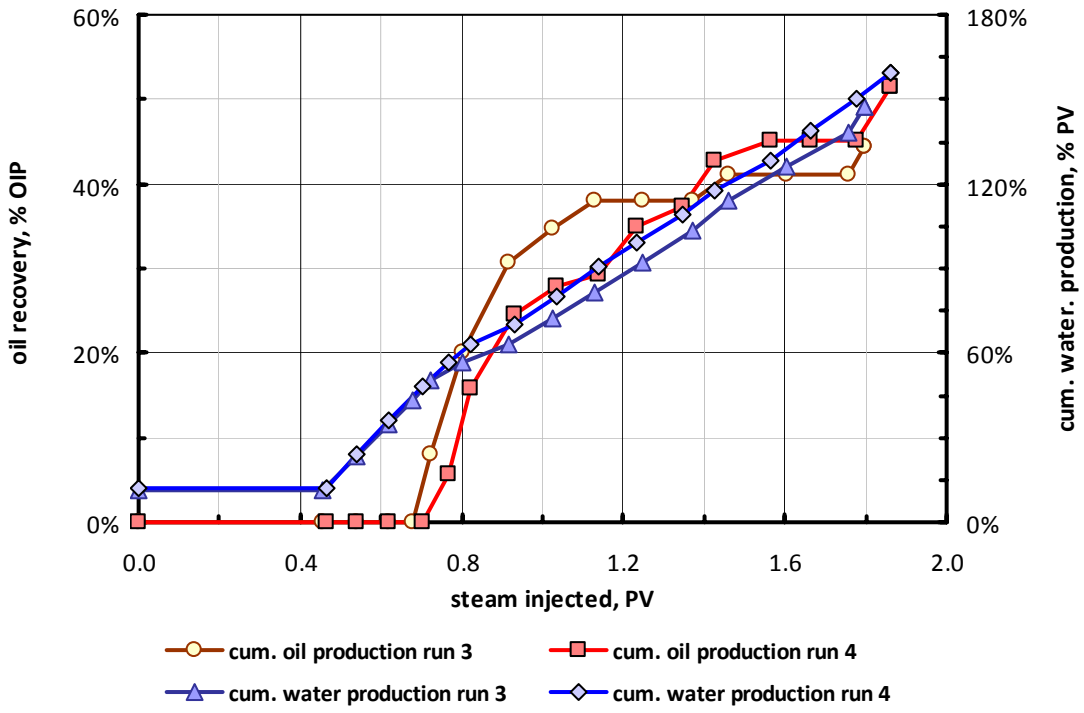

Fig. 4.17 – Oil and water cumulative production versus steam injected (PV) for runs 3 and 4 in horizontal cell.

From **Fig. 4.18** it can be seen that oilcut of the produced liquid varies for run 3 from 34% to 5% (38 to 10% for run 4). The sudden decrease of the oilcut occurs after production breaks through at the end of the cell. The oilcut at the end of injection corresponds to the cumulative production for the last half an hour of the experiment, the oil being from the top of the liquid in the separator.

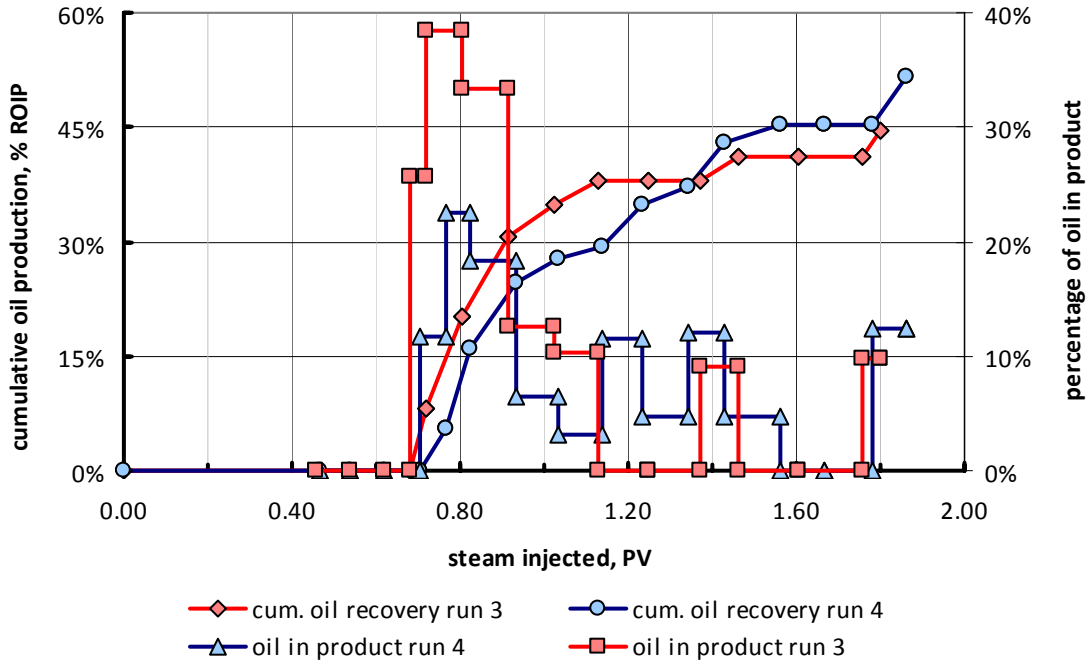

Fig. 4.18 – Oilcut produced oil and cumulative oil production versus steam injected (PV) for run 4 in horizontal cell.

The measured (at 23°C) density and viscosity values for run 4 samples are shown in **Table 4.5**:

Table 4. 5 – Density and viscosity for run 4 in horizontal cell.

Time, min	Density, g/cc	Gravity, °API	Viscosity, cp	Steam Injected, PV
0.0	0.9336	19.12	497.0	0.0000
79.5	0.9109	22.85	102.0	0.8226
90.0	0.9088	23.20	87.7	0.9312
119.0	0.9042	23.96	68.9	1.2313
138.0	0.8958	25.42	40.6	1.4278
180.0	0.8439	35.01	13.4	1.8624

4.5. Case 2: Runs 5 and 6 – Steam Injection with 3.0 wt % Solution of Surfactant TX-100 in Horizontal Cell.

This section describes the results of the steam-surfactant injection with adding 3.0 wt% TX-100 solution in water. This experiment was conducted using the horizontal cell. The steam was injected at the rate of 4.0 cc/min, the surfactant solution was injected at the rate of 1.0 cc/min. The duration of the experiment was 180 minutes, which is equal to 1.85 PV of steam injected. The experiment was run twice; the results of both experiments are shown as well as the average values of some parameters. The temperature profile is presented in **Fig. 4.19**.

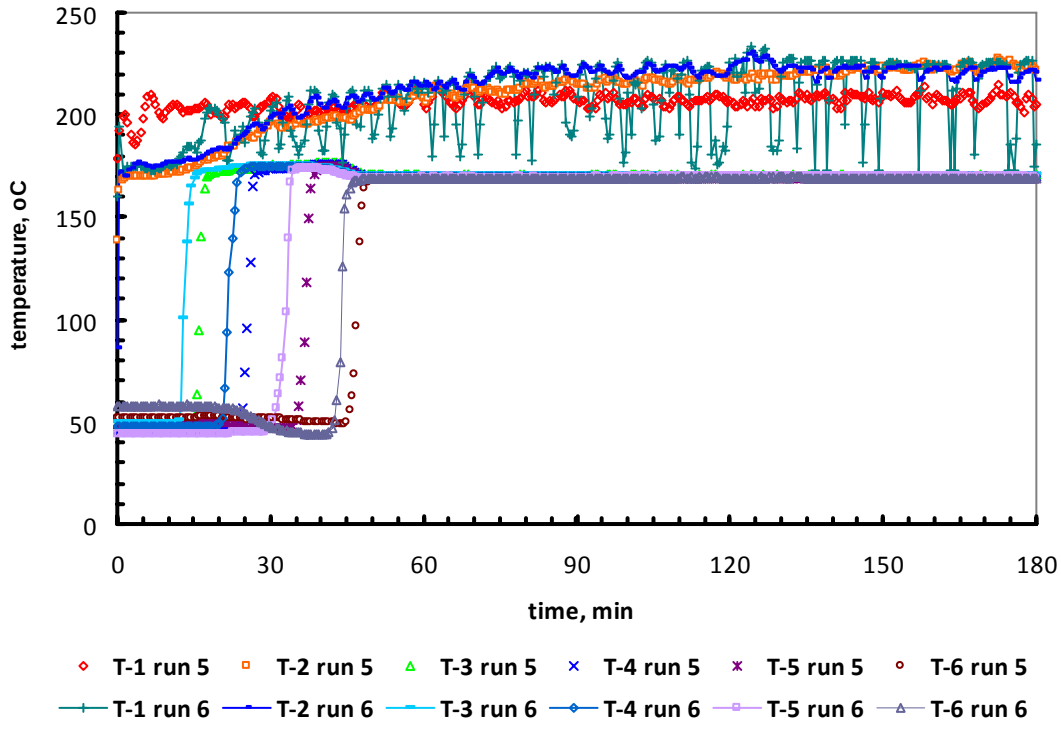

Fig. 4.19 – Temperature profile versus volume of steam injected (PV fraction) for runs 5 and 6 in horizontal cell.

As we can observe from the Fig. 4.19, a constant temperature throughout the cell was achieved when 0.5 PV of steam were injected, which means that steam front reached the production end of the cell at the 47th minute of the injection.

The injection, production and differential pressure profiles for these runs are presented in **Fig. 4.20**.

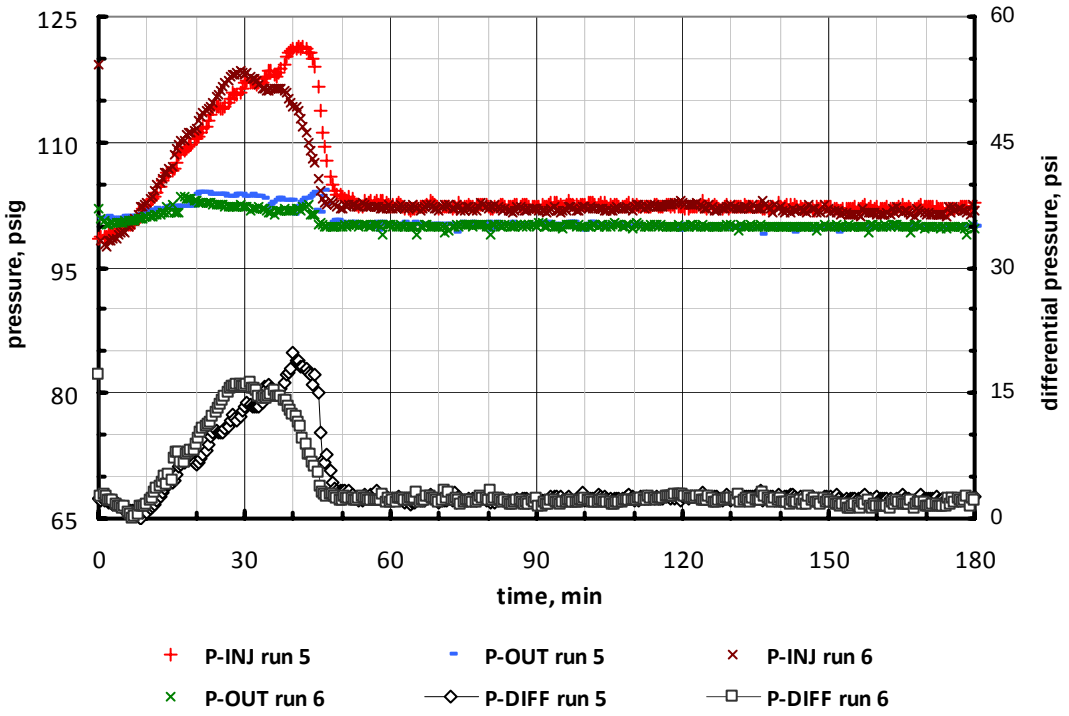

Fig. 4.20 – Injection, outlet and differential pressure versus time for runs 5 and 6 in horizontal cell.

The pressure profiles show that the outlet pressure is maintained at a constant value of approximately 100 psig and the injection pressure grows up to the highest value of 122 psig. The tendency of injection pressure to rise is due the oil bank movement along the cell, and pressure decrease to its minimum value 100 psig is indicative of oil being displaced from the cell.

The oil and water production rate profiles are shown at **Fig. 4.21** and **4.22**. It can be seen from the profiles, the maximum oil production rate of 3.4 cc/min was at the end of the steam front breakthrough. The maximum water production rate of 11.9 cc/min was

registered at the 47th minute of the injection (0.5 PV of steam injected); and the decrease of water production rate is observed at the time of steam breakthrough.

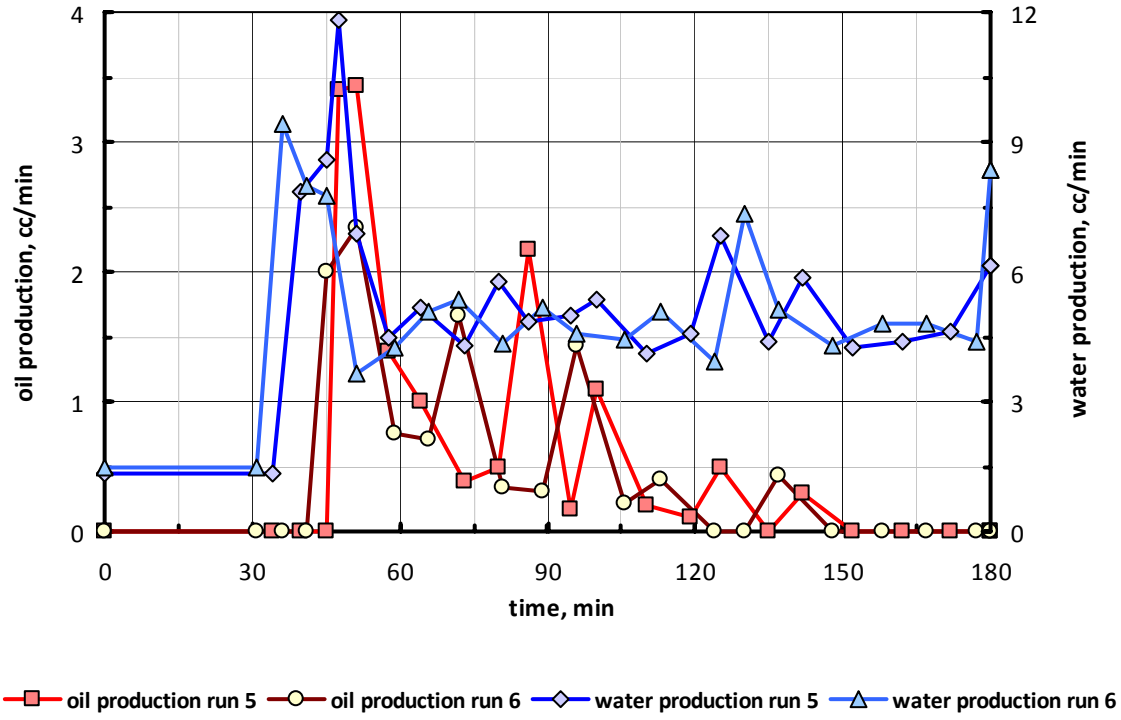

Fig. 4.21 – Oil and water production versus time for runs 5 and 6 in horizontal cell.

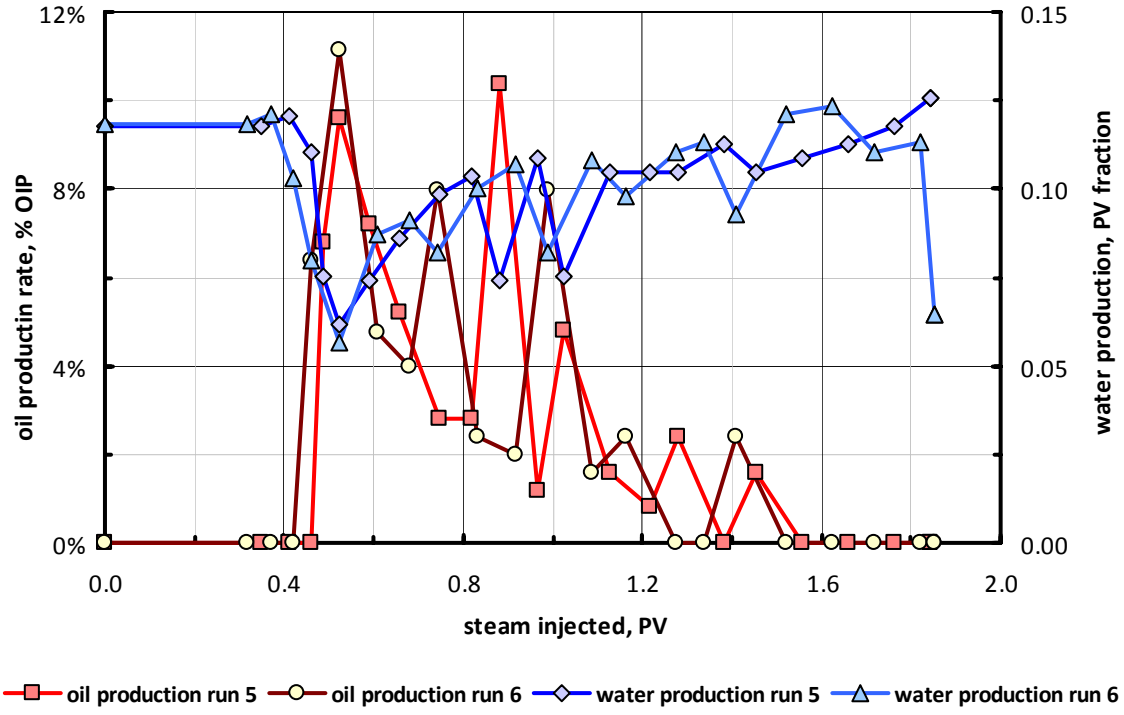

Fig. 4.22 – Oil and water production versus steam injection (PV) for runs 5 and 6 in horizontal cell.

Fig. 4.23 presents cumulative oil and water recovery production rates. For the run 5, 57% of OIP was recovered. The oil recovered in run 6 was smaller, 53% OIP. The average cumulative oil production value is 55% of OIP. The volume of water produced is about the same for both runs and equal to 2.1 pore volumes.

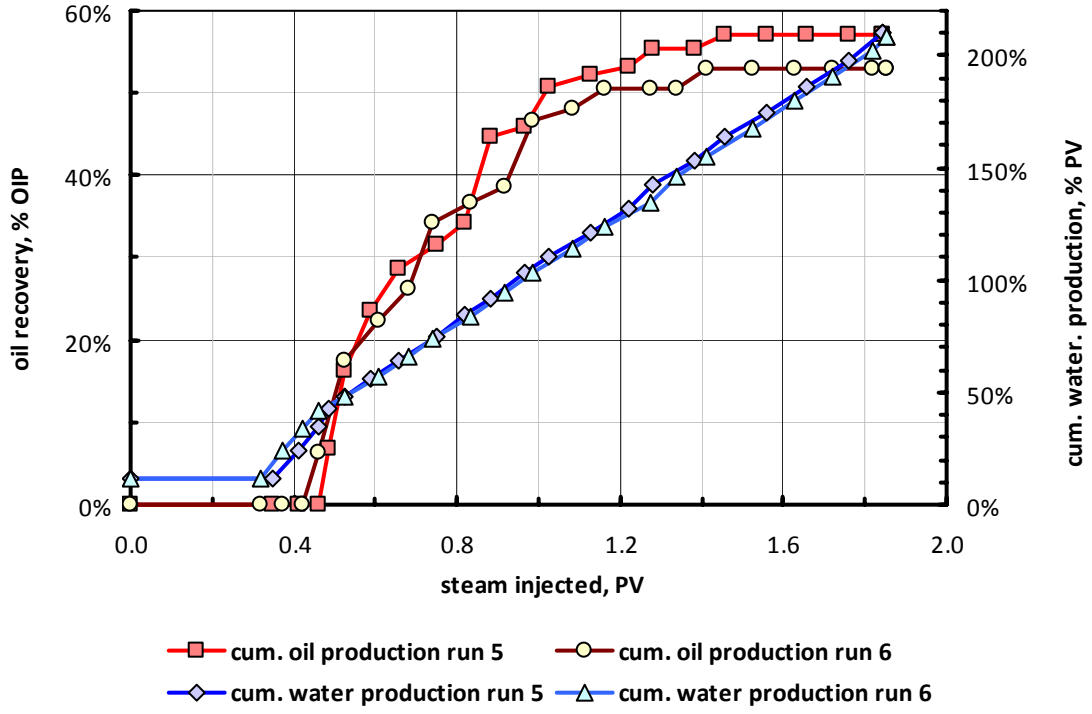

Fig. 4.23 – Oil and water cumulative production versus steam injected (PV) for runs 5 and 6 in horizontal cell.

From **Fig. 4.24** it can be seen that the oilcut in the produced fluid decreases from 39% to 5 %. The decrease of the oilcut took place after steam breakthrough.

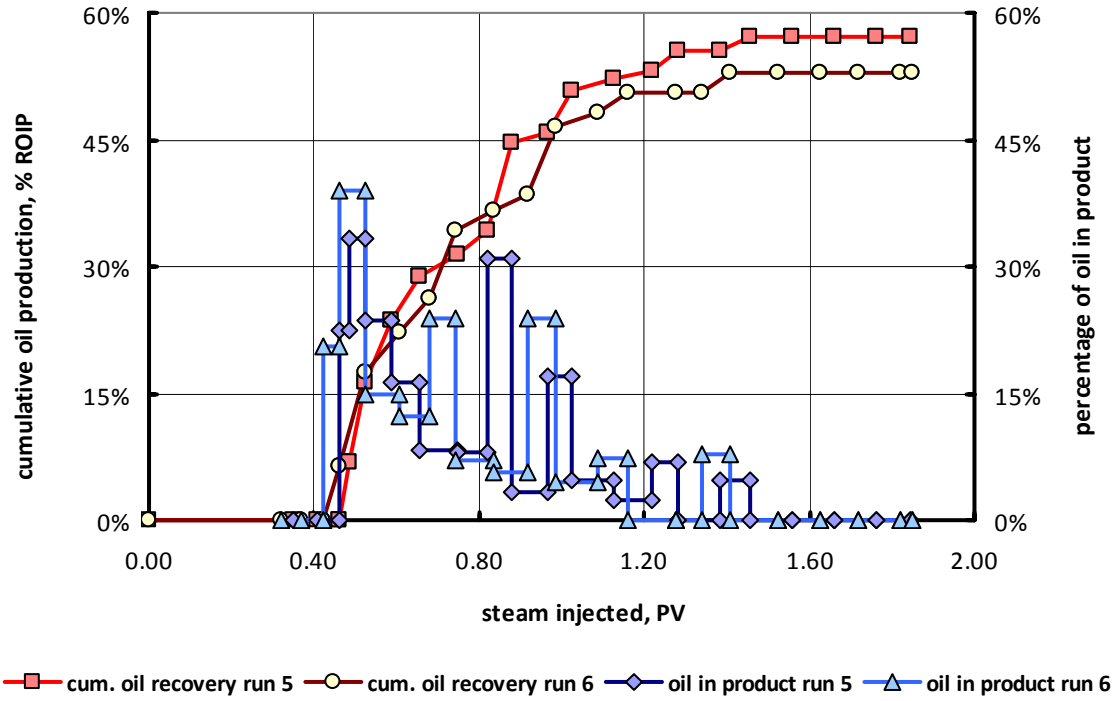

Fig. 4.24 – Produced oilcut of produced liquid and cumulative oil production versus steam injected (PV) for runs 5 and 6 in horizontal cell.

The measured at 23°C density and viscosity values for the samples taken in runs 5 and 6 are shown in **Tables 4.6** and **4.7**.

Table 4.6 – Density and viscosity for run 5 in horizontal cell.

Time, min	Density, g/cc	Gravity, ^{o} API	Viscosity, cp	Steam Injected, PV
0.0	0.9336	19.12	497.0	0.0000
47.5	0.9084	23.25	86.9	0.4865
57.5	0.9006	24.58	71.4	0.5889
64.0	0.8983	24.97	60.7	0.6555
86.0	0.8896	26.50	36.9	0.8808
100.0	0.8644	31.05	14.6	1.0242
142.0	0.8375	36.56	1.7	1.4544

Table 4.7 – Density and viscosity for run 6 in horizontal cell.

Time, min	Density, g/cc	Gravity, ^{o} API	Viscosity, cp	Steam Injected, PV
0.0	0.9336	19.12	497.0	0.0000
45.0	0.9076	23.39	91.0	0.4630
59.0	0.8992	24.82	58.5	0.6070
72.0	0.8942	25.69	47.5	0.7408
96.0	0.8740	29.28	14.5	0.9877
113.0	0.8508	33.60	8.8	1.1626

The comparison charts for density and viscosity for case 2 are presented in **Figs. 4.25** and **4.26**, correspondingly. The comparison cumulative production rates for the horizontal cell are shown in the **Fig. 4.27**.

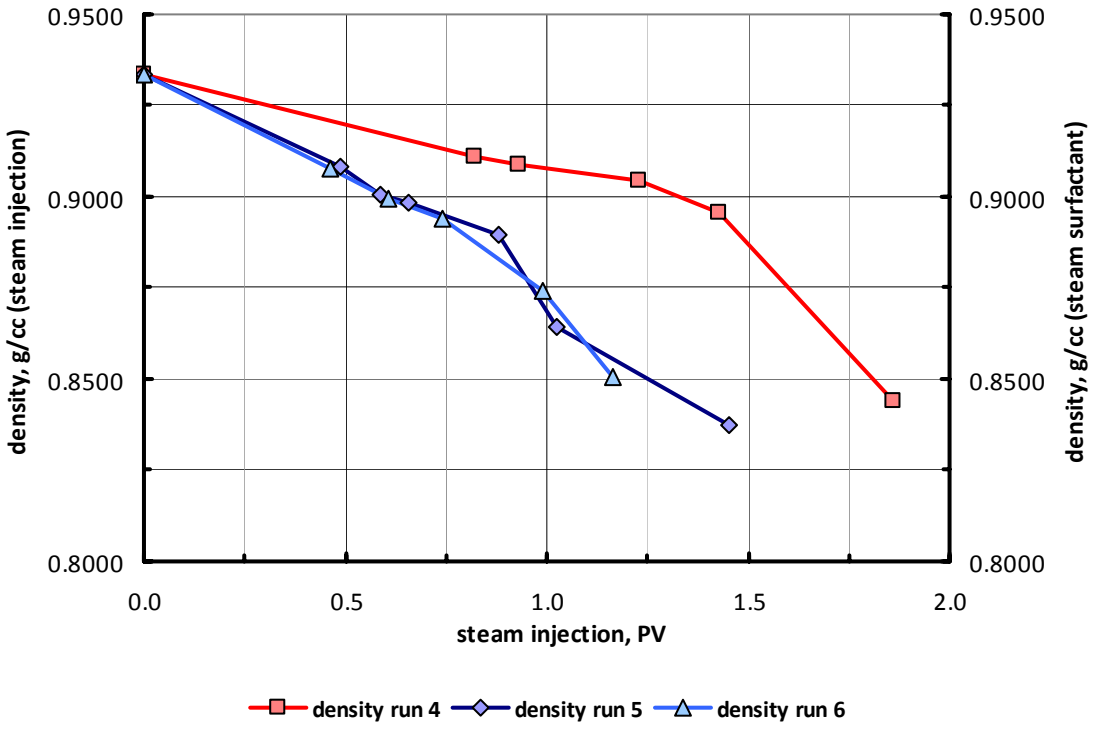

Fig. 4.25 – Oil density change versus steam injected (PV) for runs 4, 5 and 6 in horizontal cell.

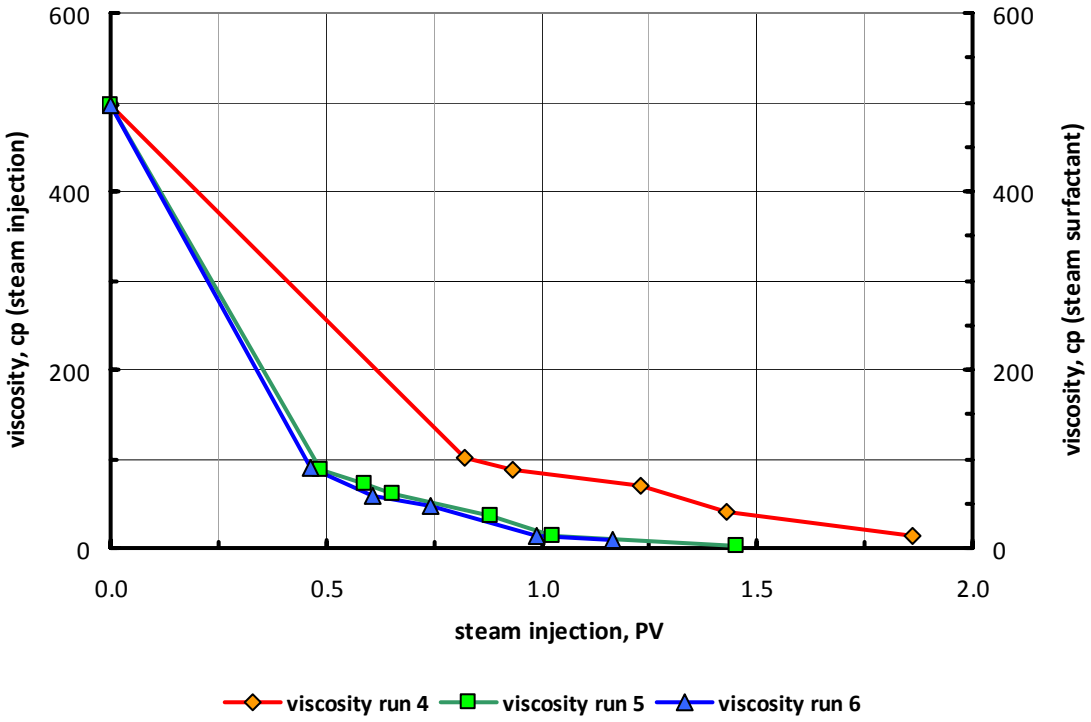

Fig. 4.26 – Oil viscosity change versus steam injected (PV) for runs 4, 5 and 6 in horizontal cell.

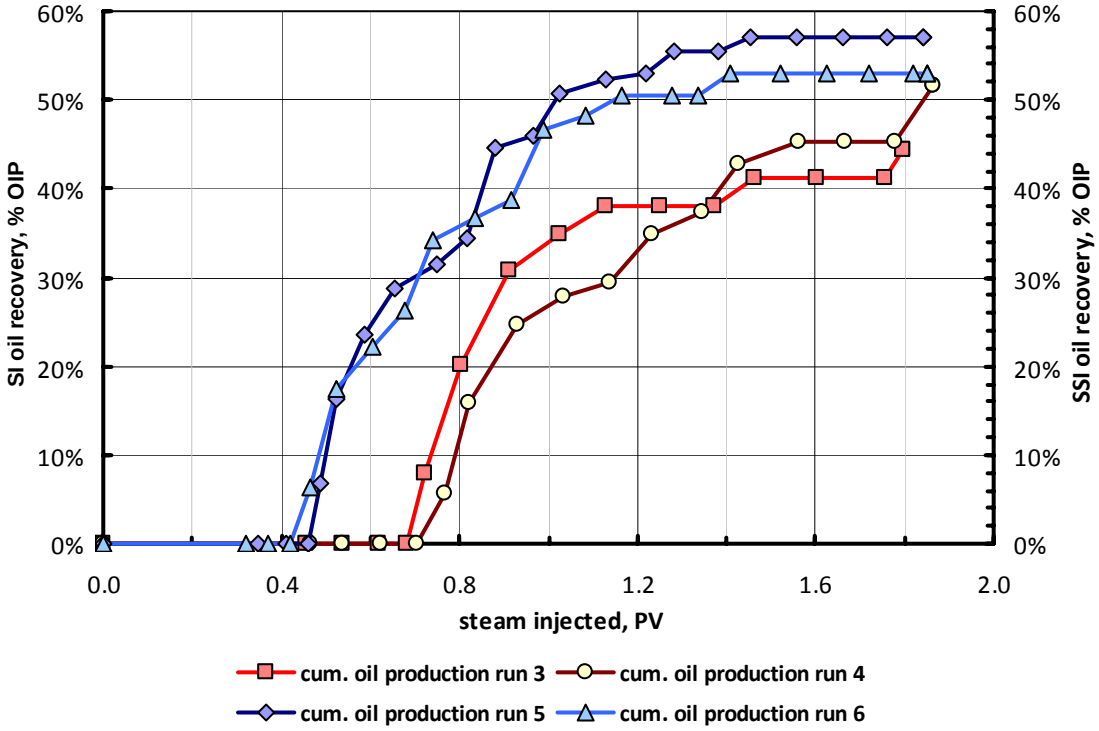

Fig. 4.27 – Comparison of cumulative oil production versus steam injected (PV) for runs 3, 4, 5 and 6 in horizontal cell.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1. Summary

Experiments were conducted to evaluate the possible benefit of steam surfactant injection compared to pure steam injection for a 20.5°API California crude oil. Two types of cells were used for the experiments, a vertical cell measuring 27 in by 2.9 in ID and a horizontal cell measuring 43.5 in by 1-$^{1}/_{16}$ in ID. The latter was used to mitigate the undesirable effects of steam channeling observed in runs with the vertical cell. Steam injection rates were fixed at 5.5 cc/min and 4.0 cc/min for the vertical and horizontal cell runs, respectively. A constant 3 wt% Triton X-100 surfactant was used for the steam surfactant runs, surfactant solution being injected at 2.5 cc/min and 1.0 cc/min for the vertical and horizontal cell runs, respectively. The initial cell temperature was set at 50°C. Superheated steam was injected at a temperature of 200°C with the cell outlet pressure kept constant at 100 psig.

A total of six runs were made, two with the vertical cell and four with the horizontal cell. For the vertical cell runs, one run was with pure steam injection, and one run was with steam and surfactant (3 wt% TX-100 solution). For the horizontal cell runs, three runs were with pure steam injection, and one run was with steam surfactant (3 wt% TX-100 solution).

5.2. Conclusions

The following main conclusions may be drawn from the experimental results.

1. Observation of sandpacks after the runs showed tendency for steam channeling in the vertical injection cell, partly due to its large diameter. The inlet-outlet pressure differential for the horizontal cell was 21 psi, while for the vertical cell, in which gravity is the main driving force and the occurrence of steam channeling, practically no pressure differential was observed. Thus the use of a horizontal injection cell with a smaller diameter than the vertical injection cell is more appropriate for the one-dimensional laboratory-scale steam injection experiments.
2. Thus for comparison purposes of oil recovery, results based on the horizontal cell runs will be used. For the two runs with pure steam injection, the average oil recovery was 48 %OIP. For the two runs with steam surfactant, the average oil recovery was 55 %OIP. That is, the use of surfactant resulted in additional oil recovery of 7.0 %OIP above that recovered with pure steam injection.
3. During the runs, the viscosity of the produced oil (measured at 23°C) decreased from the original value of 497 cp to 13.4 for steam the runs, compared to the minimum value of 1.7 cp for the steam surfactant runs. The produced oil gravity increased from an original 19.1°API to an 25.4°API for the steam runs and 36.5°API for the steam surfactant runs (compared for the 1.4 PV steam injected). The significant oil viscosity reduction is due to steam distillation effects, and is more pronounced with steam surfactant injection due to presence of surfactant in the oil.

4. For the 20.5°API California crude oil, oil-water IFT was measured to be 25 mN/m at 23°C compared to only 2.0 mN/m for oil-surfactant solution of 3 wt% TX-100.

5.3. Recommendations

Based on results of this study, the following recommendations are made.

1. For future steam and steam surfactant runs, the horizontal cell should be used as it provides a better representation of one-dimensional displacement than the vertical cell.
2. Steam surfactant runs should be made for a range of crude oil types (from light to heavy oils) and for a range of surfactant concentration. This will enable estimation of the optimum surfactant concentration for each type of crude oil.
3. Steam surfactant runs should be made for other types of surfactants to investigate those that may be most suitable for each crude oil type.
4. The thermocouples – currently inserted individually into the thermowell - should be placed in tubing for ease of operation.

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APPENDIX A

CALCULATIONS FOR OIL AND WATER SATURATIONS

FOR PREPARING SANDPACK MIXTURE FOR VERTICAL CELL

The following is a sample calculation of the fluid saturations and pore volume inside the cell. The calculations are made for all Runs.

1. Cell dimension:

   Diameter, d = 7.40 cm, height, h = 68.58 cm

   Since the cell is cylindrical, the volume of the cell is:

   $$V_{cell} = h\pi\left(\frac{d}{2}\right)^2 = 2949.52 \text{ cm}^3$$

2. The total weight of mixture (W_{mix}):

   Weight of sand, W_{sand} = 4504g

   Weight of water, W_{water} = 232g

   Weight of oil, W_{oil} = 364g

   $W_{mix} = W_{sand} + W_{water} + W_{oil}$, than W_{mix} = 4504 + 232 + 364 = 5100g

3. The weight of mixture inside the cell, W_{mix} in cell is:

   Weight of empty cell = 4254.1 g Weight of cell with mixture inside = 9181g

   Weight of mixture inside the cell, $W_{mixcell}$ = 9181 – 4254.1 = 4926.9g

4. Since the mixture is homogenous, the proportions of sand, water and oil remain constant before and after packing. The amount of each component inside the cell is then calculated below:

Weight of sand inside the cell, $W_{sandcell} = \frac{W_{mixcell}}{W_{mix}} W_{sand} = \frac{4926.9}{5100} 4504 = 4351.13g$

Weight of water inside the cell, $W_{watercell} = \frac{W_{mixcell}}{W_{mix}} W_{water} = \frac{4926.9}{5100} 232 = 224.13g$

Weight of oil inside the cell, $W_{oilcell} = \frac{W_{mixcell}}{W_{mix}} W_{oil} = \frac{4926.9}{5100} 364 = 351.65g$

5. The sand density, ρ=2.65g/ cm^3. Thus,

   Volume of sand inside the cell, $V_{sandcell} = \frac{W_{sandcell}}{\rho_{sand}} = \frac{4351.13}{2.65} = 1641.94cm^3$

6. The Porosity inside the cell is:

$$\phi = \frac{V_{cell} - V_{sandcell}}{V_{cell}} = \frac{2949.52 - 1642.94}{2949.52} = 0.443$$

7. The original Chevron California oil has an oil gravity of 20.5 ^{o}API which is equivalent 0.931 g/cm^3. Water and oil volumes inside the cell are calculated as follows:

$$V_{watercell} = \frac{W_{watercell}}{\rho_{water}} = \frac{224.13}{1} = 224.13cm^3 \quad V_{oilcell} = \frac{W_{oilcell}}{\rho_{water}} = \frac{351.65}{0.9309} = 377.75cm^3$$

8. The pore volume inside the cell is:

$$V_{porecell} = \phi \times Vcell = 0.443 \times 2949.52 = 1306.64cm^3$$

9. The saturations are calculated as follows:

$$S_w = \frac{V_{watercell}}{V_{porecell}} = \frac{224.13}{1306.64} = 0.1715 \quad S_o = \frac{V_{oilcell}}{V_{porecell}} = \frac{377.65}{1306.64} = 0.2890$$

$S_g = 1 - S_o - S_w = 0.5395$ where S_g represents the nitrogen saturation.

APPENDIX B

CALCULATIONS FOR OIL AND WATER SATURATIONS

FOR PREPARING SANDPACK MIXTURE FOR HORIZONTAL CELL

The following is a sample calculation of the fluid saturations and pore volume inside the cell. The calculations are made for all Runs.

1. Cell dimension:

   Diameter, d = 3.50 cm, length, l = 110.5 cm

   Since the cell is cylindrical, the volume of the cell is:

   $$V_{cell} = l\pi\left(\frac{d}{2}\right)^2 = 1052.0\ \text{cm}^3$$

2. The total weight of mixture (W_{mix}):

   Weight of sand, W_{sand} = 1800g

   Weight of water, W_{water} = 75g

   Weight of oil, W_{oil} = 120g

   $W_{mix} = W_{sand} + W_{water} + W_{oil}$, than W_{mix} = 1800 + 120 + 75 = 1995g

3. The weight of mixture inside the cell, W_{mix} in cell is:

   Weight of empty cell = 10361g Weight of cell with mixture inside = 12298g

   Weight of mixture inside the cell, $W_{mixcell}$ = 12298 – 10361 = 1937g

4. Since the mixture is homogenous, the proportions of sand, water and oil remain constant before and after packing. The amount of each component inside the cell is then calculated below:

Weight of sand inside the cell, $W_{sandcell} = \frac{W_{mixcell}}{W_{mix}} W_{sand} = \frac{1937}{1995} 1800 = 1747.67g$

Weight of water inside the cell, $W_{watercell} = \frac{W_{mixcell}}{W_{mix}} W_{water} = \frac{1937}{1995} 75 = 72.82g$

Weight of oil inside the cell, $W_{oilcell} = \frac{W_{mixcell}}{W_{mix}} W_{oil} = \frac{1937}{1995} 120 = 116.51g$

5. The sand density, ρ=2.65g/ cm^3. Thus,

   Volume of sand inside the cell, $V_{sandcell} = \frac{W_{sandcell}}{\rho_{sand}} = \frac{1747.67}{2.65} = 659.5cm^3$

6. The Porosity inside the cell is:

$$\phi = \frac{V_{cell} - V_{sandcell}}{V_{cell}} = \frac{1052 - 659.5}{1052} = 0.3731$$

7. The original Chevron California oil has an oil gravity of 19.12 ^{o}API which is equivalent 0.9336 g/cm^3. Water and oil volumes inside the cell are calculated as follows:

$$V_{watercell} = \frac{W_{watercell}}{\rho_{water}} = \frac{72.82}{1} = 72.82cm^3 \quad V_{oilcell} = \frac{W_{oilcell}}{\rho_{water}} = \frac{116.51}{0.9336} = 124.79cm^3$$

8. The pore volume inside the cell is:

$$V_{porecell} = \phi \times Vcell = 0.3731 \times 1052 = 392.5cm^3$$

9. The saturations are calculated as follows:

$$S_w = \frac{V_{watercell}}{V_{porecell}} = \frac{72.82}{392.5} = 0.1855 \quad S_o = \frac{V_{oilcell}}{V_{porecell}} = \frac{116.51}{392.5} = 0.2968$$

$S_g = 1 - S_o - S_w = 0.5177$ where S_g represents the nitrogen saturation.

APPENDIX C

TEMPERATURE AND PRESSURE DATA

Tables A1 and **A2** present data logs for runs One through Four:

a) Run 1: Base run for Chevron California oil with pure steam injection;

b) Run 2: Steam injection with coinjection of 3.0 wt. % solution of TX-100 surfactant;

The data in the following sets are obtained during the experiments with the vertical cell, where:

T1: Temperature at 17.7 cm above the sand mix face.

T2: Temperature at 3.1 cm above the sand mix face.

T3: Temperature at 12.0 cm into the sand mix.

T4: Temperature at 27.5 cm into the sand mix.

T5: Temperature at 42.8 cm into the sand mix.

T6: Temperature at 68 cm into the sand mix.

P_{inj}: steam injection pressure.

P_{out}: production pressure.

Table A1 – Temperature and pressure data for run 1.

Time, min	T1, °C	T2, °C	T3, °C	T4, °C	T5, °C	T6, °C	Pinj, psi	Pout, psi
0.05	168.70	47.32	49.08	52.78	52.26	46.20	127.50	101.27
0.55	188.25	149.68	48.90	52.69	52.22	46.17	97.51	98.91
1.05	198.03	165.30	49.08	52.65	52.25	46.16	97.47	99.10
1.55	203.30	167.38	49.30	52.64	52.29	46.15	97.48	99.14
2.05	205.44	167.73	49.52	52.57	52.25	46.13	97.45	99.27
2.55	205.60	167.96	49.76	52.58	52.30	46.14	97.45	99.40
3.05	204.32	168.00	49.96	52.59	52.25	46.19	97.46	99.45
3.55	202.25	167.96	50.20	52.58	52.28	46.18	97.47	99.33
4.05	199.40	167.93	50.42	52.63	52.27	46.17	97.47	99.31
4.55	196.18	168.00	50.66	52.64	52.30	46.22	97.46	99.33
5.05	193.07	168.01	50.88	52.65	52.33	46.21	97.49	99.47
5.55	190.23	168.00	51.14	52.70	52.34	46.22	97.48	99.45
6.05	187.03	167.95	51.40	52.71	52.35	46.27	97.45	99.48
6.55	183.49	168.02	51.65	52.76	52.40	46.28	97.47	99.52
7.05	182.06	167.95	51.95	52.79	52.39	46.30	97.49	99.46
7.55	180.65	167.91	52.28	52.76	52.42	46.30	97.45	99.48
8.05	179.09	167.96	52.64	52.77	52.39	46.27	97.50	99.46
8.55	177.66	168.05	52.97	52.78	52.40	46.20	97.48	99.38
9.05	176.86	167.99	53.27	52.75	52.41	46.29	97.51	99.40
9.55	176.94	168.15	53.58	52.78	52.42	46.30	97.54	99.55
10.05	179.61	168.23	53.99	52.75	52.41	46.25	97.52	99.40
10.55	183.80	168.45	54.59	52.72	52.38	46.26	97.63	99.44
11.05	187.07	168.60	55.24	52.71	52.39	46.25	97.58	99.45
11.55	189.64	168.59	55.90	52.70	52.36	46.28	97.59	99.63
12.05	190.75	168.57	56.61	52.71	52.35	46.25	97.57	99.63
12.55	190.65	168.50	57.36	52.72	52.36	46.24	97.56	99.47
13.05	189.53	168.37	58.13	52.71	52.37	46.23	97.57	99.52
13.55	188.12	168.27	59.50	52.74	52.38	46.26	97.66	99.57
14.05	186.05	168.22	63.13	52.77	52.41	46.27	97.65	99.55
14.55	184.42	168.18	64.25	52.76	52.42	46.37	97.59	99.66
15.05	182.96	168.15	64.21	52.79	52.43	46.38	97.67	99.50
15.55	181.57	168.14	66.78	52.80	52.42	46.31	97.74	99.64
16.05	182.89	168.26	67.49	52.81	52.37	46.32	97.78	99.64
16.55	185.10	168.29	67.71	52.78	52.34	46.29	97.75	99.57
17.05	184.77	168.33	69.47	52.79	52.35	46.30	97.80	100.46

17.55	185.66	168.30	71.50	52.80	52.24	46.31	97.80	100.48
18.05	185.49	168.26	75.70	52.82	52.35	46.32	97.80	99.71
18.55	184.28	168.19	78.62	52.87	52.41	46.35	97.93	99.58
19.05	183.24	168.29	87.55	52.90	52.46	46.36	97.97	100.33
19.55	184.03	168.35	91.75	52.89	52.45	46.37	98.08	99.70
20.05	185.06	168.53	105.37	52.92	52.44	46.38	98.21	100.50
20.55	185.53	168.57	115.47	52.94	52.41	46.38	98.22	100.44
21.05	185.27	168.54	123.48	52.89	52.32	46.35	98.14	99.76
21.55	183.72	168.49	127.88	52.88	52.31	46.32	98.24	99.72
22.05	183.44	168.50	132.03	52.87	52.36	46.33	98.40	99.68
22.55	183.48	168.58	134.86	52.84	52.31	46.32	98.38	100.51
23.05	183.95	168.63	137.02	52.85	52.37	46.31	98.44	100.45
23.55	184.03	168.63	139.01	52.82	52.31	46.30	98.72	100.03
24.05	183.86	168.66	141.20	52.85	52.35	46.33	98.73	99.80
24.55	184.16	168.69	143.09	52.84	52.36	46.35	98.70	100.45
25.05	184.11	168.71	144.68	52.83	52.39	46.34	98.62	100.45
25.55	184.19	168.65	146.43	52.81	52.40	46.37	98.72	100.39
26.05	185.92	168.82	149.03	52.80	52.39	46.34	99.01	100.12
26.55	189.21	169.31	154.21	52.77	52.39	46.35	99.12	99.80
27.05	191.96	169.51	159.78	52.69	52.31	46.22	98.91	99.78
27.55	193.92	169.52	163.97	52.67	52.29	46.21	98.84	99.86
28.05	194.55	169.46	166.00	52.70	52.28	46.18	98.88	99.94
28.55	193.99	169.32	167.11	52.75	52.29	46.19	98.91	100.36
29.05	192.86	169.22	167.65	52.79	52.30	46.18	98.89	99.84
29.55	190.74	169.03	167.91	52.90	52.31	46.20	98.86	99.84
30.05	188.52	168.87	168.08	53.00	52.31	46.23	98.89	99.96
30.55	186.86	168.88	168.25	53.18	52.38	46.27	99.03	100.56
31.05	187.24	169.01	168.38	53.32	52.38	46.26	99.09	100.35
31.55	187.27	169.05	168.46	53.49	52.41	46.27	99.13	100.16
32.05	187.53	169.08	168.54	53.77	52.42	46.29	99.26	99.86
32.55	188.81	169.21	168.64	54.02	52.42	46.28	99.27	99.89
33.05	189.49	169.29	168.70	54.33	52.41	46.29	99.23	100.14
33.55	189.64	169.24	168.74	54.68	52.44	46.30	99.29	100.07
34.05	188.16	169.20	168.80	55.18	52.48	46.30	99.35	100.02
34.55	187.47	169.06	168.86	55.70	52.51	46.42	99.29	100.03
35.05	187.74	169.12	168.88	56.32	52.55	46.30	99.40	99.73
35.55	187.91	169.14	168.94	57.08	52.60	46.30	99.49	99.87
36.05	185.73	169.13	169.02	58.10	52.66	46.33	99.62	99.88
36.55	186.31	169.21	169.10	59.37	52.72	46.32	100.02	99.93

37.05	186.78	169.50	169.36	61.82	52.81	46.15	100.75	99.93
37.55	187.22	169.58	169.42	67.75	52.91	46.33	100.40	99.99
38.05	188.23	169.43	169.26	74.16	52.96	46.34	99.87	100.04
38.55	188.54	169.31	169.18	80.91	53.00	46.31	99.72	100.11
39.05	188.78	169.26	169.13	86.70	53.04	46.33	99.62	99.83
39.55	188.78	169.24	169.12	92.63	53.07	46.34	99.70	100.18
40.05	188.02	169.22	169.18	100.19	53.09	46.32	99.85	99.85
40.55	188.55	169.33	169.20	108.70	53.14	46.31	99.85	100.25
41.05	190.15	169.60	169.30	120.15	53.14	46.28	100.28	100.16
41.55	194.45	170.06	169.36	135.85	53.15	46.30	100.31	100.10
42.05	198.26	170.24	169.31	149.27	53.14	46.27	100.06	99.96
42.55	200.79	170.25	169.21	156.62	53.14	46.28	99.86	100.19
43.05	201.26	170.27	169.23	161.34	53.17	46.34	99.97	100.28
43.55	200.73	170.15	169.22	163.70	53.23	46.46	100.05	100.10
44.05	199.33	169.98	169.24	164.79	53.25	46.60	99.87	100.23
44.55	196.49	169.84	169.26	165.39	53.32	46.72	100.01	100.31
45.05	194.99	169.77	169.29	165.78	53.17	46.84	100.08	100.01
45.55	192.42	169.76	169.35	166.07	53.38	46.96	100.27	100.25
46.05	192.71	169.87	169.39	166.29	53.41	47.08	100.46	100.23
46.55	193.27	169.91	169.45	166.44	53.45	47.20	100.52	100.28
47.05	193.13	169.94	169.45	166.61	53.48	47.28	100.47	100.20
47.55	192.33	169.94	169.44	166.76	53.63	47.38	100.46	99.78
48.05	191.65	169.91	169.43	166.80	53.54	47.52	100.37	100.02
48.55	192.07	169.93	169.39	166.84	53.59	47.60	100.35	99.91
49.05	191.97	169.88	169.38	166.88	53.61	47.72	100.26	100.36
49.55	191.92	169.89	169.37	166.95	53.61	47.84	100.24	100.14
50.05	193.07	170.13	169.41	167.19	53.66	47.77	100.53	100.01
50.55	196.85	170.56	169.48	167.43	53.72	48.04	100.80	100.12
51.05	200.69	170.84	169.49	167.67	53.86	48.16	100.51	99.86
51.55	204.19	170.88	169.38	167.78	54.11	48.28	100.27	100.37
52.05	205.14	170.92	169.34	167.95	54.46	48.36	100.21	99.76
52.55	204.87	170.81	169.29	168.04	55.01	48.48	99.99	99.59
53.05	203.57	170.64	169.22	168.16	55.87	48.58	99.95	100.07
53.55	201.63	170.48	169.22	168.29	57.30	48.66	99.93	100.24
54.05	198.95	170.38	169.26	168.44	59.72	48.80	100.10	100.16
54.55	198.49	170.44	169.32	168.55	63.26	48.84	100.22	99.95
55.05	198.63	170.62	169.38	168.64	67.97	48.95	100.34	100.17
55.55	198.51	170.54	169.39	168.72	74.11	49.18	100.39	100.04
56.05	198.30	170.51	169.37	168.76	82.58	49.13	100.33	99.90

56.55	195.69	170.38	169.40	168.82	95.74	49.25	100.25	99.66
57.05	196.59	170.46	169.36	168.84	106.45	49.31	100.23	99.86
57.55	197.96	170.34	169.31	168.81	113.96	49.39	100.08	99.92
58.05	198.16	170.33	169.32	168.85	120.96	49.45	100.06	99.86
58.55	199.22	170.26	169.27	168.80	126.58	49.53	99.97	99.87
59.05	199.62	170.30	169.25	168.82	132.26	49.57	100.24	99.86
59.55	196.52	170.63	169.49	169.11	141.64	49.69	100.96	99.88
60.05	194.39	170.63	169.62	169.23	150.78	49.81	101.08	99.89
60.55	195.40	170.74	169.64	169.25	158.04	49.83	101.07	99.39
61.05	197.23	170.71	169.56	169.16	162.15	49.93	100.74	99.94
61.55	198.04	170.61	169.49	169.11	163.91	50.01	100.57	99.91
62.05	196.31	170.56	169.44	169.10	164.94	50.07	100.54	99.98
62.55	197.03	170.43	169.43	169.05	165.70	50.12	100.15	99.96
63.05	198.75	170.19	169.25	168.89	165.72	50.20	99.77	99.88
63.55	197.25	170.15	169.22	168.88	165.85	50.26	99.81	99.91
64.05	195.25	170.12	169.26	168.92	166.03	50.32	100.00	99.96
64.55	195.99	170.18	169.30	168.97	166.38	50.38	100.09	99.94
65.05	197.17	170.26	169.32	169.01	166.69	50.44	100.19	100.01
65.55	197.48	170.35	169.32	169.00	166.98	50.50	100.16	99.59
66.05	195.23	170.26	169.33	169.02	167.27	50.62	100.20	100.13
66.55	194.76	170.26	169.33	169.04	167.51	50.72	100.19	99.95
67.05	196.15	170.34	169.32	169.01	167.70	50.86	100.14	99.94
67.55	197.14	170.34	169.30	168.94	167.84	51.07	100.09	99.91
68.05	197.70	170.35	169.29	168.98	167.94	51.42	100.04	100.00
68.55	196.75	170.33	169.29	168.97	168.01	51.94	100.12	99.95
69.05	193.58	170.34	169.33	169.06	168.14	52.80	100.09	99.98
69.55	193.35	170.31	169.32	169.03	168.24	54.23	100.13	99.47
70.05	195.10	170.27	169.28	168.98	168.28	56.15	100.04	99.95
70.55	195.89	170.31	169.29	169.00	168.33	58.64	100.15	99.91
71.05	195.66	170.30	169.31	169.04	168.39	61.90	100.14	100.01
71.55	196.34	170.32	169.31	169.04	168.59	66.20	100.17	99.88
72.05	196.76	170.37	169.33	169.04	168.48	71.57	100.23	99.93
72.55	194.74	170.36	169.37	169.08	168.54	78.02	100.35	99.97
73.05	194.06	170.35	169.39	169.12	168.62	84.60	100.33	100.01
73.55	193.63	170.35	169.41	169.14	168.68	91.07	100.40	99.96
74.05	195.28	170.41	169.40	169.13	168.70	98.79	100.31	99.57
74.55	196.59	170.48	169.33	169.04	168.68	107.84	100.15	100.03
75.05	196.94	170.47	169.31	169.03	168.70	114.93	100.13	99.97
75.55	194.33	170.43	169.34	169.05	168.80	120.63	100.17	99.98

76.05	193.38	170.31	169.36	169.07	168.87	126.10	100.18	100.07
76.55	195.42	170.33	169.31	169.02	168.89	130.64	100.04	99.84
77.05	196.57	170.35	169.26	168.99	168.90	133.92	99.95	99.91
77.55	194.23	170.25	169.26	169.01	168.95	136.55	99.99	99.89
78.05	192.96	170.27	169.26	169.01	169.01	138.55	100.00	99.93
78.55	194.27	170.25	169.32	169.01	169.07	140.41	99.94	99.80
79.05	196.33	170.31	169.21	168.94	169.07	142.05	99.80	99.65
79.55	197.04	170.33	169.16	168.89	169.05	143.49	99.68	99.83
80.05	197.06	170.32	169.15	168.88	169.09	143.80	99.69	99.97
80.55	197.42	170.34	169.15	168.88	169.15	144.22	99.75	99.89
81.05	196.63	170.43	169.17	168.92	169.21	144.89	99.94	99.88
81.55	194.77	170.42	169.23	168.98	169.28	146.33	99.90	99.86
82.05	195.98	170.40	169.23	168.98	169.32	147.89	99.92	100.09
82.55	196.66	170.50	169.23	169.00	169.40	149.40	100.02	99.99
83.05	196.29	170.55	169.27	169.02	169.45	151.01	100.08	99.78
83.55	193.23	170.46	169.31	169.10	169.51	153.11	100.13	99.55
84.05	193.07	170.47	169.33	169.08	169.53	155.43	100.08	99.56
84.55	195.58	170.52	169.28	169.01	169.52	157.64	100.02	99.91
85.05	196.87	170.51	169.27	168.98	169.50	158.42	99.94	99.77
85.55	196.91	170.51	169.23	168.98	169.49	159.30	99.96	99.71
86.05	194.17	170.50	169.24	168.98	169.52	159.99	99.86	99.80
86.55	195.37	170.50	169.22	168.95	169.51	160.43	99.81	99.81
87.05	196.38	170.54	169.19	168.94	169.49	160.95	99.76	99.75
87.55	196.97	170.61	169.17	168.92	169.50	161.17	99.90	99.92
88.05	197.05	170.81	169.19	168.94	169.52	161.70	99.79	99.67
88.55	199.47	170.85	169.12	168.85	169.45	162.32	99.55	99.81
89.05	200.42	170.80	169.05	168.79	169.38	162.53	99.39	99.88
89.55	200.19	170.71	169.02	168.75	169.38	162.74	99.30	99.88
90.05	200.07	170.70	168.99	168.72	169.39	162.78	99.29	99.94
90.55	200.25	170.68	168.99	168.72	169.37	162.58	99.28	99.81
91.05	200.32	170.67	168.96	168.72	169.37	162.56	99.20	99.88
91.55	200.15	170.67	168.94	168.69	169.36	162.60	99.19	99.82
92.05	199.47	170.60	168.94	168.69	169.39	162.69	99.21	99.61
92.55	197.00	170.57	168.95	168.70	169.38	162.91	99.10	99.74
93.05	197.45	170.48	168.93	168.66	169.35	163.26	99.10	99.92
93.55	195.30	170.41	168.92	168.70	169.38	163.69	99.12	99.92
94.05	196.97	170.38	168.94	168.70	169.39	164.00	99.15	99.88
94.55	197.69	170.42	168.94	168.67	169.37	164.37	99.15	99.96
95.05	198.64	170.47	168.94	168.65	169.37	164.75	99.14	99.92

95.55	199.11	170.49	168.91	168.67	169.38	165.16	99.13	99.85
96.05	198.47	170.55	168.91	168.68	169.38	165.63	99.26	99.90
96.55	195.57	170.43	168.91	168.64	169.33	166.14	98.92	99.79
97.05	197.31	170.36	168.88	168.61	169.33	166.52	98.98	99.92
97.55	198.58	170.34	168.87	168.63	169.35	166.87	98.96	99.96
98.05	199.09	170.36	168.85	168.62	169.35	167.09	98.95	100.05
98.55	199.82	170.51	168.87	168.62	169.36	167.34	99.05	99.91
99.05	198.79	170.90	168.95	168.71	169.41	167.65	99.27	99.91
99.55	201.49	171.12	168.95	168.69	169.40	167.85	99.18	99.89
100.05	204.49	171.16	168.91	168.64	169.36	167.98	99.08	99.94
100.55	205.47	171.09	168.83	168.56	169.29	168.07	98.85	99.84
101.05	205.10	170.95	168.79	168.54	169.30	168.18	98.85	99.98
101.55	204.26	170.77	168.83	168.56	169.30	168.29	98.90	99.98
102.05	203.87	170.85	168.85	168.58	169.34	168.40	99.01	99.92
102.55	203.62	170.89	168.87	168.60	169.39	168.53	99.00	99.89
103.05	203.46	170.87	168.84	168.59	169.41	168.55	98.98	99.92
103.55	203.14	170.86	168.88	168.61	169.34	168.70	98.99	99.88
104.05	203.04	170.86	168.86	168.59	169.35	168.66	98.97	99.81
104.55	202.84	170.86	168.84	168.59	169.37	168.72	98.96	99.75
105.05	202.47	170.81	168.85	168.60	169.33	168.74	98.91	99.88
105.55	202.08	170.83	168.81	168.51	169.25	168.69	98.67	99.72
106.05	202.35	170.74	168.76	168.51	169.28	168.74	98.72	99.80
106.55	202.87	170.75	168.78	168.53	169.30	168.77	98.75	99.85
107.05	203.29	170.75	168.79	168.52	169.29	168.82	98.82	99.83
107.55	202.86	170.77	168.77	168.57	169.33	168.86	98.93	99.85
108.05	202.31	170.88	168.86	168.61	169.37	168.92	99.08	99.89
108.55	201.70	170.93	168.90	168.65	169.40	168.97	99.18	100.30
109.05	200.59	170.92	168.96	168.69	169.44	168.99	99.22	100.00
109.55	200.83	170.99	168.92	168.63	169.43	169.01	99.13	99.94
110.05	201.28	170.87	168.87	168.60	169.34	168.96	98.89	99.76
110.55	201.08	170.87	168.82	168.57	169.34	169.00	98.86	99.86
111.05	201.41	170.80	168.82	168.57	169.36	168.98	98.88	99.90
111.55	201.89	170.73	168.82	168.57	169.35	168.99	98.87	99.86
112.05	202.48	170.77	168.81	168.56	169.35	169.01	98.86	99.87
112.55	202.31	170.74	168.83	168.58	169.35	169.03	98.86	99.92
113.05	202.11	170.75	168.83	168.56	169.35	169.05	98.90	99.75
113.55	202.13	170.81	168.83	168.60	169.35	169.07	98.91	99.87
114.05	202.35	170.80	168.83	168.58	169.36	169.05	98.95	99.89
114.55	200.08	170.82	168.89	168.62	169.39	169.16	99.03	99.90

115.05	201.01	170.78	168.93	168.64	169.42	169.09	99.06	100.00
115.55	201.44	170.89	168.91	168.66	169.56	169.04	99.15	99.93
116.05	201.37	171.02	168.95	168.68	169.44	169.20	99.18	99.93
116.55	197.72	171.02	168.94	168.67	169.42	169.12	99.05	99.65
117.05	199.07	170.92	168.85	168.60	169.35	169.06	98.92	99.76
117.55	200.47	170.90	168.85	168.60	169.39	169.08	98.96	99.94
118.05	201.36	170.90	168.85	168.60	169.37	169.10	98.93	99.75
118.55	202.19	170.85	168.84	168.57	169.36	169.09	98.92	99.77
119.05	202.89	170.82	168.82	168.59	169.38	169.14	98.88	99.74
119.55	203.72	170.77	168.84	168.57	169.34	169.11	98.84	99.79
120.05	204.42	170.80	168.81	168.55	169.22	169.10	98.83	99.85
120.55	201.23	170.86	168.83	168.59	169.38	169.10	98.95	99.81
121.05	201.43	170.68	168.85	168.61	169.48	169.14	98.93	99.82
121.55	202.35	170.72	168.85	168.60	169.39	169.19	98.98	99.75
122.05	202.56	170.87	168.87	168.62	169.25	169.14	99.05	99.75
122.55	199.57	170.94	168.87	168.67	169.43	169.25	99.06	99.83
123.05	197.62	170.85	168.91	168.69	169.36	169.21	99.09	99.83
123.55	199.17	170.80	168.89	168.62	169.38	169.16	98.94	99.57
124.05	200.40	170.87	168.84	168.55	169.22	169.13	98.92	99.87
124.55	201.37	170.87	168.84	168.59	169.38	169.16	98.96	99.74
125.05	202.34	170.93	168.86	168.59	169.37	169.15	98.95	99.87
125.55	199.33	170.97	168.88	168.63	169.40	169.12	99.03	99.80
126.05	200.52	170.84	168.87	168.63	169.39	169.21	99.00	99.79
126.55	201.09	170.86	168.87	168.62	169.39	169.14	98.97	99.83
127.05	201.90	170.85	168.85	168.60	169.37	169.16	98.93	99.77
127.55	202.03	170.76	168.84	168.62	169.38	169.16	98.90	100.01
128.05	202.10	170.76	168.82	168.57	169.38	169.14	98.88	99.81
128.55	202.39	170.73	168.82	168.57	169.38	169.15	98.88	99.88
129.05	201.87	170.75	168.83	168.59	169.36	169.17	98.89	99.95
129.55	202.25	170.82	168.83	168.59	169.24	169.15	98.96	99.82
130.05	202.49	170.84	168.83	168.61	169.39	169.21	98.98	99.82
130.55	198.42	170.79	168.88	168.63	169.28	169.23	99.03	99.93
131.05	199.36	170.85	168.87	168.60	169.34	169.14	98.82	99.65
131.55	200.51	170.87	168.82	168.58	169.36	169.12	98.91	99.93
132.05	200.87	170.92	168.85	168.64	169.41	169.18	99.02	99.81
132.55	201.03	171.02	168.86	168.62	169.40	169.16	99.03	99.89
133.05	201.19	171.00	168.88	168.62	169.40	169.18	99.03	99.91
133.55	201.61	171.02	168.86	168.61	169.38	169.18	99.01	99.91
134.05	201.95	171.02	168.86	168.61	169.40	169.17	99.02	99.82

134.55	202.33	170.99	168.87	168.59	169.39	169.21	98.98	99.84
135.05	202.83	171.04	168.83	168.60	169.39	169.19	98.95	99.96
135.55	199.70	170.96	168.87	168.62	169.39	169.21	98.98	99.92
136.05	201.37	170.83	168.85	168.62	169.39	169.18	98.93	99.83
136.55	202.80	170.87	168.84	168.59	169.39	169.27	98.96	99.86
137.05	202.68	170.84	168.84	168.62	169.40	169.18	98.98	99.90
137.55	202.11	170.93	168.84	168.59	169.40	169.20	98.99	99.92
138.05	201.73	170.93	168.81	168.55	169.20	169.15	98.79	99.73
138.55	201.20	170.91	168.79	168.54	169.35	169.13	98.82	99.86
139.05	201.43	170.88	168.79	168.56	169.35	169.15	98.87	99.91
139.55	201.99	170.88	168.81	168.58	169.35	169.16	98.86	100.02
140.05	202.78	171.05	168.82	168.56	169.36	169.16	98.88	99.94
140.55	203.28	171.07	168.82	168.58	169.36	169.16	98.89	99.91
141.05	202.69	171.10	168.80	168.57	169.36	169.18	99.03	99.87
141.55	199.24	171.05	168.86	168.64	169.38	169.20	98.98	99.95
142.05	200.46	171.11	168.86	168.61	169.40	169.18	99.00	99.89
142.55	201.64	171.18	168.86	168.61	169.40	169.19	98.98	99.80
143.05	201.66	171.17	168.86	168.61	169.39	169.21	99.04	99.87
143.55	200.90	171.17	168.87	168.62	169.42	169.21	99.07	99.91
144.05	200.72	171.24	168.87	168.64	169.41	169.23	99.04	99.83
144.55	201.17	171.21	168.85	168.64	169.43	169.21	99.05	99.84
145.05	201.30	171.23	168.85	168.62	169.39	169.20	98.96	99.81
145.55	201.58	171.07	168.77	168.53	169.31	169.13	98.71	99.72
146.05	201.44	171.18	168.77	168.53	169.34	169.15	98.79	99.86
146.55	201.80	171.06	168.77	168.54	169.33	169.15	98.76	99.77
147.05	201.29	171.04	168.77	168.50	169.33	169.06	98.80	99.84
147.55	201.59	171.02	168.77	168.54	169.48	169.17	98.80	99.81
148.05	201.15	171.01	168.81	168.56	169.33	169.15	98.85	99.80
148.55	200.40	171.06	168.81	168.56	169.37	169.17	98.88	99.81
149.05	200.74	171.07	168.82	168.58	169.36	169.19	98.89	99.75
149.55	201.22	171.05	168.82	168.57	169.39	169.18	98.91	99.82
150.05	201.69	171.20	168.82	168.57	169.38	169.18	98.94	99.76
150.55	202.02	171.25	168.82	168.59	169.38	169.20	98.97	99.90
151.05	199.12	171.36	168.88	168.63	169.42	169.22	99.11	99.91
151.55	198.62	171.26	168.92	168.66	169.58	169.22	99.06	99.86
152.05	199.91	171.29	168.88	168.65	169.42	169.23	99.08	99.94
152.55	200.40	171.24	168.89	168.63	169.43	169.23	99.03	99.90
153.05	201.06	171.17	168.85	168.62	169.39	169.21	98.98	99.80
153.55	201.74	171.05	168.84	168.60	169.39	169.21	98.95	99.77

154.05	201.92	171.05	168.80	168.55	169.34	169.18	98.79	99.64
154.55	202.27	171.00	168.77	168.52	169.31	169.15	98.69	99.78
155.05	203.00	171.02	168.73	168.52	169.31	169.15	98.70	99.78
155.55	203.67	170.98	168.75	168.50	169.28	169.15	98.77	99.78
156.05	204.53	171.09	168.79	168.54	169.47	169.15	98.79	99.80
156.54	202.65	171.13	168.81	168.58	169.53	169.19	98.88	99.85
157.05	202.26	171.01	168.81	168.58	169.39	169.19	98.90	99.71
157.55	197.89	171.08	168.85	168.64	169.41	169.23	98.91	99.74
158.05	199.50	170.98	168.84	168.58	169.39	169.23	98.99	99.74
158.55	200.35	171.05	168.87	168.60	169.40	169.22	98.96	99.83
159.05	200.56	171.05	168.84	168.61	169.24	169.22	98.98	99.83
159.55	200.66	171.04	168.84	168.61	169.42	169.22	99.00	99.74
160.05	200.53	171.13	168.81	168.57	169.37	169.18	98.88	99.59
160.55	199.82	171.15	168.81	168.58	169.40	169.22	98.90	99.84
161.05	200.12	171.21	168.83	168.58	169.37	169.19	98.91	99.76
161.55	200.63	171.17	168.81	168.56	169.37	169.21	98.89	99.92
162.05	201.54	171.17	168.82	168.56	169.36	169.19	98.86	99.89
162.55	202.73	171.26	168.80	168.57	169.48	169.12	98.83	99.75
163.05	203.84	171.30	168.80	168.53	169.22	169.16	98.83	99.77
163.55	204.40	171.30	168.79	168.55	169.34	169.13	98.80	99.80
164.05	204.74	171.23	168.75	168.53	169.33	169.17	98.76	99.80
164.55	200.14	171.05	168.79	168.59	169.36	169.20	98.81	99.69
165.05	200.98	170.98	168.77	168.59	169.37	169.19	98.83	99.70
165.55	201.81	170.99	168.79	168.56	169.37	169.19	98.84	99.98
166.05	202.29	171.19	168.81	168.58	169.39	169.19	98.85	99.87
166.55	202.65	171.30	168.79	168.58	169.33	169.25	98.90	99.73
167.05	203.19	171.41	168.81	168.58	169.37	169.23	98.93	99.80
167.55	203.75	171.41	168.82	168.58	169.37	169.21	98.90	99.81
168.05	204.18	171.46	168.80	168.58	169.38	169.20	98.94	99.83
168.55	204.09	171.61	168.84	168.59	169.38	169.20	98.97	99.83
169.05	203.20	171.70	168.84	168.64	169.40	169.24	99.03	99.84
169.55	200.98	171.68	168.86	168.63	169.45	169.26	99.25	99.83
170.05	195.18	171.44	168.92	168.63	169.42	169.24	98.98	99.65
170.55	195.81	171.53	168.84	168.63	169.39	169.22	98.91	99.63
171.05	198.60	171.64	168.81	168.58	169.35	169.19	98.86	99.78
171.55	200.31	171.68	168.80	168.58	169.37	169.21	98.91	99.80
172.05	201.27	171.75	168.83	168.58	169.36	169.18	98.90	99.73
172.55	202.31	171.84	168.84	168.57	169.36	169.18	98.87	99.74
173.05	203.43	171.95	168.80	168.57	169.36	169.20	98.91	99.77

173.55	203.91	171.99	168.82	168.57	169.36	169.20	98.92	99.90
174.05	204.47	171.88	168.80	168.55	169.36	169.18	98.86	99.80
174.55	204.86	171.95	168.81	168.54	169.36	169.18	98.87	99.83
175.05	205.01	171.90	168.79	168.56	169.37	169.20	98.89	99.84
175.55	204.88	171.96	168.81	168.56	169.35	169.24	98.90	99.83
176.05	199.26	171.67	168.81	168.56	169.37	169.19	98.82	99.71
176.55	199.14	171.44	168.80	168.58	169.36	169.21	98.90	99.83
177.05	198.98	171.41	168.82	168.58	169.36	169.21	98.84	99.75
177.55	201.13	171.55	168.82	168.57	169.38	169.21	98.97	99.79
178.05	202.23	171.64	168.78	168.51	169.31	169.18	98.73	99.72
178.55	203.23	171.65	168.79	168.55	169.34	169.20	98.82	99.74
179.05	204.04	171.77	168.77	168.55	169.35	169.22	98.84	99.60
179.55	204.29	171.81	168.79	168.55	169.35	169.20	98.86	99.79
180.05	204.19	171.87	168.79	168.54	169.49	169.19	98.84	99.69

Table A2 – Temperature and pressure data for run 2.

Time, min	T1, °C	T2, °C	T3, °C	T4, °C	T5, °C	T6, °C	Pinj, psi	Pout, psi
0.05	39.32	42.27	48.56	53.17	52.92	47.93	121.79	102.97
0.55	49.26	43.00	48.54	53.15	52.90	47.91	99.70	101.21
1.05	55.34	42.90	48.50	53.15	52.88	47.89	100.08	101.67
1.55	119.97	43.11	48.48	53.07	52.86	47.81	100.51	102.26
2.05	170.31	47.18	48.27	52.69	52.71	47.72	100.76	102.53
2.54	171.93	92.90	48.25	52.67	52.66	47.74	101.08	102.86
3.05	173.89	156.76	48.31	52.77	52.69	47.78	101.51	103.39
3.55	176.89	167.47	48.39	52.86	52.83	47.85	101.81	103.53
4.05	180.95	168.94	48.42	52.84	52.90	47.91	101.71	103.42
4.55	184.29	169.25	48.50	52.86	52.96	47.99	101.60	103.35
5.05	187.50	169.54	48.52	52.86	53.03	48.04	101.54	103.30
5.55	190.19	169.92	48.54	52.86	53.05	48.10	101.46	103.06
6.05	191.48	170.01	48.56	52.84	53.05	48.10	101.09	102.92
6.55	190.85	169.86	48.59	52.88	53.05	48.12	101.50	102.92
7.05	190.56	169.82	48.63	52.88	53.05	48.14	101.31	102.60
7.55	190.37	169.86	48.61	52.88	53.07	48.14	101.21	102.66
8.05	190.22	169.83	48.65	52.90	53.07	48.15	101.32	102.61
8.55	190.35	169.90	48.69	52.90	53.09	48.16	101.11	102.47
9.05	190.65	170.01	48.71	52.90	53.09	48.18	101.12	102.56
9.55	192.32	170.19	48.73	52.92	53.09	48.17	101.26	102.45
10.05	193.31	170.31	48.73	52.90	53.09	48.15	101.22	102.39
10.55	192.73	170.45	48.76	52.88	53.09	48.17	101.26	102.37
11.05	193.36	170.62	48.82	52.90	53.07	48.15	101.40	102.31
11.55	194.15	170.89	48.94	52.88	53.07	48.18	101.40	102.41
12.05	195.98	171.26	49.01	52.82	52.94	48.15	101.37	102.30
12.54	197.37	171.64	49.17	52.83	53.05	48.12	101.92	102.40
13.05	197.14	171.86	49.38	52.83	53.05	48.16	102.09	102.57
13.55	197.27	172.00	49.72	52.81	53.05	48.12	102.36	102.72
14.05	197.68	172.15	50.06	52.77	53.05	48.16	103.02	103.01
14.55	198.09	172.22	50.52	52.75	53.07	48.16	103.26	103.07
15.05	198.68	172.24	51.17	52.71	53.07	48.14	103.78	103.34
15.55	199.34	172.26	52.01	52.73	53.11	48.16	104.06	103.47
16.05	199.81	172.35	53.02	52.73	53.09	48.14	104.49	103.71
16.55	200.08	172.63	54.46	52.73	53.13	48.14	104.77	103.71
17.05	200.06	172.69	57.16	52.70	53.04	48.16	104.96	103.69

17.55	199.29	172.65	66.80	52.69	53.02	48.14	104.91	103.80
18.05	198.93	172.63	90.85	52.60	52.98	48.12	104.87	103.62
18.55	198.83	172.63	126.45	52.56	52.86	48.14	104.66	103.59
19.05	198.84	172.62	150.48	52.46	52.86	48.12	104.67	103.36
19.55	198.75	172.69	161.85	52.39	52.85	48.06	104.65	103.27
20.05	198.70	172.71	166.82	52.22	52.86	48.00	104.85	103.23
20.55	198.66	172.80	168.96	52.12	52.88	48.00	104.80	103.10
21.05	198.40	172.83	169.86	51.99	52.88	48.04	104.80	103.05
21.55	198.34	172.80	170.28	51.93	52.94	48.10	104.86	103.05
22.05	198.70	172.81	170.44	51.84	52.94	48.08	104.69	102.92
22.55	199.00	172.79	170.54	51.78	52.96	48.02	104.93	102.84
23.05	198.75	172.78	170.63	51.66	52.98	47.91	104.95	102.87
23.55	199.06	172.83	170.69	51.59	52.99	47.95	105.02	102.84
24.05	199.24	172.92	170.72	51.51	53.17	47.93	105.08	102.80
24.55	199.16	172.94	170.76	51.43	53.11	47.91	105.18	102.76
25.05	199.09	172.83	170.80	51.40	53.15	47.91	105.08	102.91
25.54	199.11	172.87	170.85	51.53	53.19	47.91	105.14	102.80
26.05	199.02	172.90	170.90	51.89	53.22	47.93	105.45	102.82
26.55	198.82	173.01	170.96	52.79	53.28	47.96	105.55	102.80
27.05	199.04	173.12	171.07	54.69	53.38	48.04	105.83	102.74
27.55	199.09	173.17	171.17	58.33	53.45	48.04	106.12	102.70
28.05	199.05	173.17	171.23	64.20	53.49	48.04	106.29	102.73
28.55	199.07	173.28	171.32	73.07	53.55	48.04	106.41	102.82
29.05	199.29	173.31	171.33	85.75	53.55	48.06	106.30	102.90
29.55	199.11	173.31	171.32	99.50	53.64	48.15	106.37	102.87
30.05	199.57	173.33	171.33	114.00	53.58	48.31	106.39	102.82
30.55	199.55	173.29	171.37	126.96	53.62	48.46	106.44	102.80
31.05	199.68	173.27	171.40	136.39	53.68	48.61	106.64	102.81
31.55	199.53	173.27	171.44	142.81	53.56	48.72	106.64	102.66
32.05	199.27	173.26	171.47	147.03	53.69	48.87	106.72	102.61
32.55	199.53	173.31	171.55	150.26	53.60	49.01	106.94	102.70
33.05	199.50	173.36	171.60	153.13	53.62	49.10	107.12	102.54
33.55	199.68	173.51	171.65	156.21	53.63	49.23	107.20	102.61
34.05	199.48	173.43	171.63	159.45	53.65	49.37	106.98	102.77
34.55	199.62	173.38	171.60	162.21	53.61	49.50	106.99	102.77
35.05	199.84	173.38	171.60	164.31	53.61	49.60	106.89	102.82
35.55	200.14	173.40	171.60	165.87	53.61	49.73	106.94	102.74
36.05	200.44	173.34	171.61	167.02	53.67	49.86	106.87	102.90
36.55	200.42	173.41	171.60	167.83	53.82	49.96	106.89	102.75

37.05	200.35	173.37	171.61	168.37	54.35	50.07	106.95	102.65
37.55	200.35	173.41	171.58	168.73	55.63	50.22	106.47	100.04
38.05	200.51	173.30	171.38	168.91	58.17	50.39	106.06	101.59
38.55	200.58	173.21	171.31	169.13	62.05	50.52	106.11	101.91
39.05	200.46	173.21	171.34	169.36	67.31	50.62	106.19	102.21
39.55	200.53	173.19	171.38	169.59	73.47	50.71	106.22	99.50
40.05	200.62	173.08	171.23	169.59	81.87	50.85	105.58	101.45
40.55	200.65	172.94	171.16	169.72	92.39	50.92	105.52	101.96
41.05	200.45	172.90	171.14	169.90	102.10	51.05	105.48	102.18
41.55	200.53	172.88	171.16	170.04	110.21	51.13	105.67	102.23
42.05	200.34	172.92	171.21	170.24	117.18	51.22	105.88	102.38
42.55	200.38	172.95	171.25	170.35	123.76	51.28	105.62	100.42
43.05	200.56	172.93	171.10	170.25	130.69	51.41	105.25	101.52
43.55	200.57	172.88	171.06	170.33	135.97	51.49	105.23	101.95
44.05	200.38	172.97	171.10	170.41	139.83	51.56	105.49	101.96
44.55	200.54	173.02	171.17	170.54	143.46	51.64	105.71	102.07
45.05	200.46	173.11	171.28	170.64	147.08	51.71	105.88	99.76
45.55	200.34	173.11	171.17	170.56	151.41	51.81	105.35	101.23
46.05	200.50	173.07	171.11	170.54	153.80	51.92	105.36	101.73
46.55	200.21	172.98	171.15	170.61	155.57	52.11	105.48	101.94
47.05	200.26	173.05	171.20	170.68	157.32	52.49	105.63	102.11
47.55	200.48	173.07	171.31	170.75	158.66	53.34	105.85	102.28
48.05	200.65	173.19	171.29	170.80	160.33	55.40	105.85	99.88
48.55	200.53	173.14	171.07	170.57	162.62	61.10	105.04	101.06
49.05	200.47	173.05	171.00	170.53	163.94	66.74	104.95	101.75
49.55	200.60	173.14	171.03	170.56	164.66	71.13	105.17	101.92
50.05	200.74	173.15	171.07	170.64	165.23	74.33	105.36	102.08
50.55	200.90	173.26	171.19	170.76	165.83	76.88	105.63	102.14
51.05	200.86	173.28	171.23	170.78	166.58	79.51	105.35	100.59
51.55	200.63	173.17	171.05	170.61	167.10	82.63	104.92	101.41
52.05	200.61	173.17	171.04	170.63	167.28	85.36	105.09	101.82
52.55	200.55	173.15	171.08	170.70	167.53	87.71	105.19	101.99
53.05	200.64	173.16	171.09	170.74	167.80	89.89	105.43	102.26
53.55	200.62	173.27	171.17	170.81	167.96	92.20	105.54	102.19
54.05	200.66	173.34	171.24	170.86	168.03	94.69	105.66	102.28
54.55	200.60	173.34	171.18	170.75	168.09	97.81	105.18	101.04
55.05	200.69	173.27	171.07	170.71	168.01	102.27	105.09	101.66
55.55	200.55	173.23	171.11	170.73	167.92	106.78	105.31	101.84
56.05	200.49	173.26	171.14	170.78	167.87	111.02	105.41	102.09

56.55	200.31	173.34	171.18	170.83	167.94	115.16	105.46	102.45
57.05	199.88	173.33	171.10	170.71	167.83	119.58	104.74	100.61
57.55	199.86	173.15	170.83	170.42	168.04	125.01	104.13	101.66
58.05	199.81	172.97	170.74	170.38	168.53	129.37	104.10	102.00
58.55	200.04	172.90	170.70	170.34	168.98	132.93	104.07	102.09
59.05	200.00	172.99	170.70	170.38	169.44	135.95	104.11	102.17
59.55	200.02	172.90	170.68	170.31	169.71	139.15	103.67	99.90
60.05	199.91	172.75	170.39	170.00	169.69	144.18	102.85	100.91
60.55	200.00	172.57	170.25	169.93	169.87	146.81	102.75	101.24
61.05	200.14	172.55	170.27	169.94	170.05	148.39	102.82	101.45
61.55	199.92	172.51	170.32	169.98	170.21	149.69	102.90	101.62
62.05	200.12	172.58	170.30	169.98	170.21	150.81	102.82	99.82
62.55	200.08	172.55	170.10	169.74	170.05	153.27	102.08	100.70
63.05	200.08	172.46	170.03	169.69	170.17	154.68	102.11	101.09
63.55	199.81	172.40	170.04	169.74	170.19	155.69	102.22	101.23
64.05	199.63	172.43	170.08	169.79	170.15	156.66	102.43	101.36
64.55	199.66	172.52	170.15	169.82	170.34	157.51	102.51	100.65
65.05	199.54	172.52	170.00	169.64	170.09	158.99	101.80	100.65
65.55	199.46	172.39	169.91	169.60	170.11	159.75	101.74	100.98
66.05	199.30	172.39	169.91	169.62	170.16	160.20	101.89	101.09
66.55	199.41	172.42	169.98	169.67	170.21	160.52	102.07	101.41
67.05	199.39	172.46	169.99	169.69	170.19	161.04	101.85	100.06
67.55	198.97	172.42	169.83	169.49	170.03	162.36	101.38	100.53
68.05	198.74	172.28	169.81	169.50	170.19	163.31	101.44	100.82
68.55	198.68	172.20	169.86	169.58	170.15	164.08	101.58	101.08
69.05	198.68	172.27	169.90	169.61	170.11	164.82	101.78	101.16
69.55	198.77	172.22	169.95	169.65	170.26	165.49	101.87	100.22
70.05	198.71	172.22	169.79	169.43	169.97	166.10	101.08	100.46
70.55	198.86	172.16	169.71	169.41	169.98	166.53	101.14	100.70
71.05	198.84	172.14	169.71	169.42	170.04	166.83	101.27	100.80
71.55	198.91	172.14	169.78	169.48	170.09	167.14	101.41	100.95
72.05	198.62	172.23	169.82	169.55	170.16	167.39	101.51	101.14
72.55	198.58	172.21	169.85	169.53	170.07	167.62	101.17	99.73
73.05	198.47	172.24	169.72	169.38	169.99	167.91	101.01	100.50
73.55	198.74	172.13	169.72	169.42	170.03	168.23	101.12	100.58
74.05	198.81	172.20	169.74	169.45	170.19	168.49	101.27	100.64
74.55	198.82	172.25	169.75	169.45	170.08	168.73	101.31	100.72
75.05	198.84	172.24	169.79	169.50	170.13	168.91	101.38	100.83
75.55	198.93	172.22	169.70	169.39	169.95	168.89	100.91	100.31

76.05	199.11	172.09	169.64	169.34	169.98	168.96	100.95	100.46
76.55	199.19	172.16	169.66	169.35	169.95	169.10	100.93	100.39
77.04	199.34	172.25	169.66	169.37	169.98	169.17	100.95	100.32
77.55	199.03	172.23	169.64	169.35	169.98	169.22	100.91	100.46
78.05	198.83	172.22	169.67	169.34	169.83	169.24	100.80	99.95
78.55	199.31	172.22	169.56	169.24	169.87	169.24	100.64	100.24
79.05	199.19	172.24	169.56	169.25	169.90	169.25	100.69	100.26
79.55	199.13	172.17	169.54	169.25	169.88	169.31	100.75	100.29
80.05	199.22	172.11	169.54	169.27	169.88	169.32	100.66	100.16
80.55	199.38	172.16	169.54	169.27	169.90	169.34	100.68	100.39
81.05	199.25	172.20	169.52	169.19	169.82	169.28	100.44	100.16
81.55	198.87	172.18	169.53	169.21	169.84	169.32	100.54	100.20
82.04	198.89	172.18	169.51	169.21	169.87	169.37	100.56	100.25
82.55	199.08	172.23	169.51	169.24	169.87	169.40	100.60	100.09
83.05	199.17	172.26	169.53	169.22	169.89	169.40	100.54	100.25
83.55	199.19	172.22	169.47	169.22	169.87	169.40	100.62	100.19
84.05	199.33	172.28	169.51	169.22	169.83	169.40	100.53	100.17
84.55	199.27	172.31	169.50	169.23	169.88	169.45	100.59	100.21
85.05	199.38	172.20	169.54	169.25	169.88	169.45	100.57	99.79
85.55	199.49	172.18	169.47	169.18	169.86	169.39	100.45	100.14
86.05	199.32	172.25	169.50	169.21	169.88	169.50	100.52	100.22
86.55	199.55	172.23	169.52	169.19	169.77	169.44	100.53	100.17
87.05	199.29	172.20	169.52	169.23	169.88	169.50	100.45	100.07
87.55	199.54	172.20	169.53	169.21	169.87	169.46	100.47	100.10
88.05	199.46	172.18	169.50	169.21	169.87	169.48	100.48	100.21
88.55	199.41	172.21	169.51	169.21	169.89	169.44	100.43	99.90
89.05	199.39	172.24	169.46	169.17	169.82	169.42	100.33	100.20
89.55	199.69	172.26	169.47	169.18	169.85	169.47	100.47	100.25
90.05	199.54	172.26	169.47	169.22	169.85	169.49	100.49	100.20
90.55	199.38	172.20	169.49	169.20	169.86	169.49	100.47	100.18
91.05	199.26	172.20	169.48	169.22	169.86	169.48	100.45	100.16
91.55	199.29	172.25	169.48	169.21	169.90	169.48	100.48	100.17
92.05	199.57	172.25	169.48	169.19	169.84	169.48	100.44	100.13
92.55	199.52	172.25	169.48	169.19	169.88	169.52	100.47	100.31
93.05	199.55	172.34	169.51	169.24	169.91	169.55	100.62	100.24
93.55	199.48	172.26	169.51	169.24	169.91	169.55	100.57	100.16
94.05	199.26	172.23	169.51	169.22	169.85	169.49	100.36	99.87
94.55	199.40	172.21	169.40	169.15	169.81	169.45	100.25	100.06
95.05	199.35	172.19	169.47	169.22	169.92	169.53	100.43	100.36

95.55	199.63	172.26	169.47	169.22	169.88	169.52	100.51	100.14
96.05	199.69	172.33	169.49	169.22	169.86	169.52	100.42	100.30
96.55	199.33	172.33	169.49	169.20	169.85	169.50	100.45	100.10
97.05	199.16	172.33	169.48	169.21	169.88	169.52	100.40	100.06
97.55	199.33	172.33	169.47	169.20	169.86	169.54	100.51	100.21
98.05	199.30	172.32	169.50	169.23	169.90	169.55	100.39	99.76
98.55	198.73	172.27	169.44	169.16	169.82	169.48	100.27	99.98
99.05	198.73	172.25	169.46	169.14	169.78	169.48	100.17	100.00
99.55	198.87	172.23	169.42	169.15	169.84	169.49	100.24	100.16
100.05	199.08	172.24	169.46	169.19	169.87	169.55	100.40	100.21
100.55	198.65	172.19	169.47	169.18	169.96	169.54	100.40	100.14
101.05	198.79	172.21	169.45	169.18	169.85	169.49	100.38	100.19
101.55	199.01	172.22	169.45	169.20	169.87	169.53	100.40	100.14
102.05	198.84	172.24	169.47	169.20	169.86	169.52	100.37	100.21
102.54	199.04	172.27	169.45	169.16	169.85	169.49	100.33	100.17
103.05	198.95	172.31	169.47	169.20	169.88	169.55	100.40	100.03
103.55	199.04	172.24	169.48	169.23	169.81	169.57	100.51	100.01
104.05	199.05	172.25	169.44	169.16	169.80	169.52	100.24	99.94
104.55	198.93	172.25	169.43	169.16	169.82	169.52	100.24	100.16
105.05	198.96	172.27	169.44	169.17	169.88	169.61	100.36	100.23
105.55	198.91	172.30	169.46	169.19	169.87	169.55	100.42	100.06
106.05	199.10	172.32	169.46	169.19	169.85	169.53	100.29	100.12
106.55	198.94	172.34	169.44	169.13	169.83	169.51	100.26	100.15
107.05	198.78	172.32	169.46	169.17	169.87	169.55	100.31	100.25
107.55	198.76	172.31	169.47	169.22	169.87	169.56	100.36	100.20
108.05	198.60	172.31	169.45	169.18	169.87	169.56	100.38	100.25
108.55	198.67	172.28	169.45	169.18	169.88	169.56	100.41	100.39
109.05	198.90	172.38	169.47	169.23	169.90	169.58	100.45	100.40
109.55	198.66	172.36	169.50	169.21	169.92	169.61	100.49	100.34
110.05	198.56	172.31	169.45	169.16	169.74	169.52	100.16	100.28
110.54	198.32	172.22	169.41	169.16	169.82	169.50	100.25	100.21
111.05	198.19	172.23	169.43	169.14	169.86	169.55	100.36	100.19
111.55	198.25	172.25	169.44	169.18	169.88	169.61	100.40	100.27
112.05	198.43	172.25	169.46	169.19	169.88	169.57	100.31	100.24
112.55	198.24	172.26	169.46	169.23	169.93	169.57	100.31	100.17
113.05	198.37	172.25	169.44	169.19	169.85	169.55	100.26	100.28
113.55	198.47	172.30	169.44	169.17	169.85	169.56	100.34	100.13
114.05	197.99	172.26	169.42	169.19	169.87	169.55	100.30	100.15
114.55	198.37	172.33	169.44	169.18	169.87	169.56	100.29	100.04

115.05	198.35	172.37	169.47	169.18	169.89	169.56	100.33	100.05
115.54	198.54	172.37	169.42	169.16	169.81	169.51	100.17	99.96
116.05	198.70	172.44	169.40	169.13	169.81	169.52	100.20	100.16
116.55	198.47	172.40	169.41	169.16	169.86	169.56	100.28	100.35
117.05	198.23	172.42	169.43	169.18	169.88	169.56	100.33	100.32
117.55	198.27	172.42	169.47	169.18	169.86	169.56	100.29	100.25
118.05	198.12	172.29	169.43	169.12	169.82	169.56	100.20	100.10
118.55	198.45	172.29	169.43	169.16	169.84	169.56	100.30	100.10
119.05	198.28	172.32	169.45	169.18	169.99	169.52	100.29	100.13
119.55	198.12	172.36	169.46	169.17	169.86	169.57	100.30	100.19
120.05	198.05	172.39	169.46	169.19	169.88	169.57	100.29	100.19
120.55	198.19	172.39	169.46	169.19	169.87	169.59	100.33	100.21
121.05	198.25	172.41	169.52	169.23	169.91	169.62	100.45	100.34
121.55	198.25	172.43	169.48	169.19	169.96	169.57	100.26	99.91
122.05	198.51	172.39	169.44	169.17	169.85	169.57	100.25	100.14
122.55	198.40	172.46	169.44	169.17	169.85	169.57	100.23	100.29
123.05	198.30	172.44	169.44	169.19	169.87	169.57	100.27	100.29
123.55	198.29	172.43	169.49	169.19	169.87	169.58	100.33	100.18
124.05	198.30	172.41	169.46	169.19	169.87	169.58	100.28	100.15
124.55	198.19	172.39	169.47	169.17	169.96	169.60	100.26	100.13
125.05	198.10	172.40	169.45	169.17	169.87	169.58	100.25	100.29
125.55	198.02	172.44	169.44	169.18	169.87	169.58	100.27	100.13
126.05	197.92	172.42	169.45	169.18	169.79	169.60	100.35	100.18
126.55	197.93	172.31	169.47	169.20	169.90	169.60	100.33	100.07
127.05	198.33	172.35	169.42	169.13	169.81	169.52	100.18	99.99
127.55	198.25	172.37	169.38	169.11	169.79	169.51	100.04	100.06
128.05	198.13	172.35	169.42	169.14	169.87	169.58	100.26	100.27
128.55	198.15	172.40	169.45	169.18	169.99	169.58	100.37	100.43
129.05	198.29	172.40	169.45	169.16	169.88	169.58	100.27	100.14
129.55	198.57	172.44	169.41	169.14	169.85	169.56	100.25	100.17
130.05	198.50	172.42	169.43	169.16	169.86	169.56	100.29	100.22
130.55	198.30	172.52	169.45	169.18	169.86	169.57	100.27	100.14
131.05	198.84	172.54	169.43	169.16	169.86	169.59	100.28	100.15
131.55	198.64	172.58	169.45	169.18	169.99	169.59	100.28	100.17
132.05	198.37	172.56	169.46	169.19	169.90	169.61	100.32	100.24
132.55	198.23	172.56	169.48	169.18	169.86	169.57	100.17	99.95
133.05	198.34	172.54	169.43	169.16	169.86	169.55	100.20	99.98
133.55	198.46	172.59	169.39	169.12	169.82	169.53	100.17	100.23
134.05	198.39	172.54	169.43	169.16	169.86	169.59	100.25	100.29

134.55	198.57	172.56	169.43	169.16	169.97	169.57	100.30	100.36
135.05	199.14	172.65	169.46	169.15	169.87	169.59	100.32	100.16
135.55	199.21	172.68	169.42	169.15	169.84	169.57	100.23	100.10
136.05	199.12	172.57	169.42	169.14	169.86	169.57	100.25	100.30
136.55	198.87	172.59	169.46	169.17	169.87	169.60	100.21	100.29
137.05	198.46	172.57	169.42	169.15	169.86	169.60	100.21	100.14
137.55	198.64	172.61	169.44	169.15	169.87	169.60	100.24	100.20
138.05	198.82	172.61	169.46	169.17	169.89	169.62	100.32	100.13
138.55	198.91	172.61	169.40	169.15	169.82	169.55	100.15	99.80
139.05	198.69	172.53	169.40	169.12	169.82	169.58	100.18	100.30
139.55	198.80	172.55	169.42	169.17	169.85	169.60	100.29	100.26
140.05	198.85	172.61	169.46	169.19	169.89	169.62	100.33	100.21
140.55	198.89	172.62	169.44	169.17	169.89	169.60	100.26	100.08
141.05	198.71	172.64	169.42	169.15	169.87	169.58	100.22	100.16
141.55	198.96	172.66	169.40	169.13	169.83	169.57	100.16	100.07
142.05	198.85	172.61	169.42	169.15	169.82	169.58	100.20	100.19
142.55	198.87	172.64	169.42	169.17	169.89	169.60	100.24	100.30
143.05	199.05	172.66	169.42	169.17	169.87	169.62	100.26	100.19
143.55	198.69	172.59	169.48	169.17	169.87	169.58	100.27	100.20
144.05	198.35	172.55	169.46	169.17	169.91	169.62	100.28	100.30
144.55	198.49	172.55	169.47	169.19	169.85	169.60	100.24	99.86
145.05	198.98	172.55	169.42	169.13	169.82	169.55	100.14	100.08
145.55	198.85	172.62	169.42	169.15	169.85	169.56	100.18	100.20
146.05	198.96	172.61	169.44	169.17	169.87	169.60	100.23	100.20
146.55	199.32	172.69	169.44	169.19	169.89	169.62	100.29	100.32
147.05	198.99	172.64	169.44	169.13	169.85	169.60	100.24	100.16
147.55	199.24	172.68	169.44	169.17	169.87	169.58	100.28	100.31
148.05	198.83	172.68	169.44	169.17	169.89	169.62	100.27	100.14
148.55	199.15	172.62	169.44	169.17	169.87	169.62	100.25	100.19
149.05	199.08	172.71	169.44	169.17	169.87	169.60	100.22	100.26
149.55	199.10	172.69	169.42	169.15	169.87	169.60	100.33	100.23
150.05	198.99	172.73	169.44	169.19	169.87	169.62	100.30	100.43
150.55	198.76	172.71	169.37	169.13	169.83	169.58	100.24	100.40
151.05	198.49	172.73	169.42	169.11	169.83	169.57	100.17	100.22
151.55	198.38	172.64	169.39	169.12	169.85	169.60	100.22	100.40
152.05	198.65	172.66	169.40	169.15	169.87	169.62	100.33	100.37
152.55	198.51	172.64	169.40	169.15	169.85	169.58	100.25	100.47
153.05	198.32	172.66	169.42	169.15	169.85	169.60	100.28	100.37
153.55	198.26	172.68	169.42	169.17	169.91	169.60	100.30	100.47

154.05	197.85	172.57	169.41	169.15	169.86	169.62	100.29	100.43
154.55	198.43	172.57	169.43	169.16	169.88	169.61	100.33	100.38
155.05	198.66	172.61	169.43	169.16	169.86	169.61	100.41	100.54
155.55	198.70	172.72	169.39	169.10	169.80	169.55	100.17	100.33
156.05	198.64	172.72	169.36	169.09	169.79	169.54	100.17	100.55
156.54	198.29	172.78	169.41	169.16	169.88	169.61	100.32	100.59
157.05	198.47	172.74	169.41	169.14	169.86	169.61	100.38	100.55
157.55	198.65	172.74	169.41	169.16	169.88	169.65	100.33	100.63
158.05	198.93	172.81	169.45	169.16	169.86	169.63	100.38	100.53
158.55	198.97	172.83	169.43	169.16	169.88	169.61	100.34	100.58
159.05	198.93	172.91	169.40	169.15	169.85	169.60	100.33	100.51
159.55	198.49	172.96	169.42	169.15	169.87	169.61	100.42	100.48
160.05	198.27	172.89	169.44	169.17	169.87	169.62	100.41	100.58
160.55	198.69	172.94	169.42	169.13	169.89	169.62	100.41	100.62
161.05	199.14	172.91	169.42	169.15	169.87	169.64	100.47	100.94
161.55	199.14	172.89	169.44	169.15	169.85	169.60	100.33	100.43
162.05	198.91	172.86	169.39	169.10	169.71	169.57	100.32	100.70
162.55	198.94	172.95	169.39	169.14	169.84	169.59	100.40	100.58
163.05	199.16	172.91	169.41	169.14	169.77	169.60	100.48	100.73
163.55	198.86	172.95	169.43	169.15	169.88	169.60	100.45	100.70
164.05	199.50	172.86	169.41	169.14	169.84	169.61	100.38	100.65
164.54	199.31	172.83	169.41	169.14	169.84	169.59	100.37	100.85
165.05	199.02	172.81	169.39	169.14	169.88	169.61	100.44	100.70
165.55	199.20	172.83	169.41	169.16	169.92	169.63	100.40	100.72
166.05	199.52	172.92	169.43	169.18	169.90	169.65	100.49	100.86
166.55	199.47	172.85	169.43	169.16	169.86	169.63	100.45	100.81
167.05	199.04	172.73	169.42	169.16	169.76	169.61	100.50	100.79
167.55	198.87	172.76	169.42	169.16	169.78	169.63	100.56	100.81
168.05	199.12	172.84	169.42	169.13	169.83	169.58	100.39	100.77
168.55	199.39	172.89	169.38	169.10	169.83	169.58	100.36	100.78
169.05	199.10	172.86	169.39	169.15	169.85	169.58	100.43	100.73
169.54	199.08	172.84	169.39	169.14	169.87	169.60	100.44	100.90
170.05	198.87	172.84	169.39	169.14	169.86	169.59	100.50	100.92
170.55	199.02	172.86	169.41	169.16	169.84	169.62	100.44	100.92
171.05	199.04	172.83	169.39	169.14	169.84	169.61	100.47	100.87
171.55	198.99	172.83	169.39	169.12	169.86	169.61	100.41	100.71
172.05	198.90	172.85	169.41	169.13	169.86	169.59	100.44	100.88
172.55	198.74	172.76	169.40	169.14	169.85	169.61	100.38	100.82
173.05	198.94	172.84	169.40	169.13	169.87	169.62	100.44	100.93

173.55	198.69	172.82	169.40	169.15	169.90	169.62	100.51	100.80
174.05	199.10	172.86	169.42	169.17	169.87	169.60	100.46	100.94
174.55	198.87	172.75	169.39	169.12	169.82	169.57	100.39	100.80
175.05	198.85	172.81	169.40	169.14	169.87	169.57	100.56	100.90
175.55	198.96	172.84	169.42	169.16	169.88	169.64	100.47	100.89
176.05	199.07	172.81	169.43	169.14	169.90	169.61	100.58	100.91
176.55	199.16	172.87	169.39	169.14	169.90	169.59	100.47	100.76
177.05	198.93	172.81	169.40	169.14	169.86	169.61	100.44	100.79
177.55	198.50	172.74	169.40	169.15	169.85	169.61	100.44	100.78
178.05	198.49	172.67	169.38	169.13	169.83	169.60	100.50	100.73
178.55	198.63	172.68	169.38	169.13	169.83	169.62	100.47	100.79
179.05	198.48	172.70	169.38	169.13	169.76	169.64	100.46	100.80
179.55	198.33	172.71	169.40	169.15	169.87	169.62	100.56	100.93
180.05	198.30	172.63	169.41	169.14	169.84	169.57	100.35	100.52

APPENDIX D

TEMPERATURE AND PRESSURE DATA

Tables B1 through **B4** present data logs for runs Five through Eight:

c) Runs 3 and 4: Two Base runs for Chevron California oil with pure steam injection;

d) Runs 5 and 6: Steam injection with coinjection of 3 wt. % solution of TX-100 surfactant;

The data in the following sets are obtained during the experiments with the horizontal cell, where:

T1: temperature at 1.5 cm above the sand mix face.

T2: temperature at 1.3 cm below the sand mix face.

T3: temperature at 27.3 cm below the sand mix face.

T4: temperature at 53.3 cm below the sand mix face.

T5: temperature at 79.3 cm below the sand mix face.

T6: temperature at 105.3 cm below the sand mix face.

P_{inj}: steam injection pressure.

P_{out}: production pressure.

Table B1 – Temperature and pressure data for run 3.

Time, min	T1, oC	T2, oC	T3, oC	T4, oC	T5, oC	T6, oC	Pinj, psi	Pout, psi
0.05	125.44	73.31	52.65	47.29	49.58	56.09	119.27	102.96
0.55	202.12	155.80	52.82	47.30	49.70	56.27	99.19	101.69
1.05	212.43	162.99	52.85	47.28	49.71	56.29	98.84	101.42
1.55	180.80	163.79	52.86	47.27	49.64	56.24	98.84	101.36
2.05	184.31	167.22	52.90	47.32	49.64	56.27	99.23	100.83
2.55	190.19	168.39	52.95	47.30	49.63	56.25	99.31	100.92
3.05	195.11	169.51	52.95	47.33	49.64	56.24	99.41	101.27
3.55	210.39	169.81	52.94	47.34	49.66	56.25	99.61	101.01
4.05	221.38	169.99	52.95	47.36	49.69	56.25	99.59	101.82
4.55	195.54	170.07	52.95	47.31	49.62	56.18	99.71	101.06
5.05	173.84	169.95	52.94	47.28	49.59	56.17	99.31	101.01
5.55	171.32	170.01	52.96	47.30	49.57	56.14	99.76	101.04
6.05	170.83	170.12	52.95	47.29	49.56	56.14	100.03	101.32
6.55	170.42	170.18	52.96	47.29	49.57	56.13	100.10	101.83
7.05	170.41	170.28	52.96	47.28	49.53	56.12	100.24	101.92
7.55	170.64	170.39	52.97	47.29	49.56	56.11	100.28	101.29
8.05	170.85	170.56	52.95	47.29	49.55	56.09	100.49	101.22
8.55	171.07	170.66	52.94	47.26	49.57	56.10	100.35	101.26
9.05	178.59	170.68	52.95	47.27	49.57	56.10	100.56	101.94
9.55	184.97	171.03	52.97	47.27	49.60	56.11	100.74	101.29
10.05	184.38	171.08	52.96	47.26	49.59	56.13	101.00	101.30
10.55	187.61	171.31	53.04	47.26	49.57	56.14	101.15	101.32
11.05	192.24	171.35	53.33	47.27	49.69	56.11	101.24	101.26
11.55	187.64	171.17	53.58	47.22	49.57	56.13	101.33	102.18
12.05	187.97	171.68	53.89	47.20	49.53	56.14	101.76	102.02
12.55	219.59	171.85	54.22	47.25	49.56	56.24	101.52	101.46
13.05	232.76	172.07	54.53	47.25	49.56	56.30	101.92	101.37
13.55	234.57	172.24	54.88	47.28	49.57	56.29	102.26	101.34
14.05	233.70	172.37	55.23	47.32	49.57	56.31	102.40	101.31
14.55	231.36	172.59	55.61	47.31	49.58	56.33	102.72	101.33
15.05	228.95	172.68	56.04	47.31	49.58	56.32	102.81	102.04
15.55	226.23	172.74	56.42	47.30	49.61	56.27	102.91	102.14
16.05	223.21	172.91	56.90	47.27	49.61	56.23	103.22	101.42
16.55	221.44	172.91	57.40	47.23	49.66	56.20	103.21	101.99
17.05	219.57	172.95	57.88	47.22	49.68	56.17	103.30	101.52

17.55	217.28	172.98	58.41	47.22	49.69	56.18	103.39	101.51
18.05	214.51	173.05	59.03	47.19	49.71	56.18	103.62	101.48
18.55	212.08	173.22	59.83	47.18	49.64	56.20	104.23	101.39
19.05	210.01	173.37	60.95	47.24	49.59	56.23	104.61	101.37
19.55	207.94	173.39	64.38	47.24	49.55	56.23	104.63	101.48
20.05	207.30	173.40	76.52	47.23	49.56	56.26	104.86	101.52
20.55	208.29	173.69	107.16	47.20	49.60	56.30	105.01	101.57
21.05	208.71	173.85	153.37	47.16	49.64	56.32	105.27	101.54
21.55	209.18	174.00	166.66	47.11	49.65	56.33	105.52	101.84
22.05	209.27	174.24	169.04	47.04	49.62	56.28	105.68	101.51
22.55	209.60	174.43	169.86	46.97	49.62	56.19	105.85	101.67
23.05	209.08	174.39	170.46	46.97	49.61	56.11	105.96	101.56
23.55	208.60	174.56	170.69	46.96	49.61	56.02	106.46	101.52
24.05	208.25	174.69	171.00	46.98	49.58	55.95	106.66	101.50
24.55	207.47	174.66	171.17	47.00	49.54	55.88	106.77	101.50
25.05	206.50	174.57	171.32	47.07	49.51	55.81	106.82	101.42
25.54	205.20	174.47	171.39	47.13	49.44	55.74	106.84	101.43
26.05	203.74	174.62	171.47	47.21	49.35	55.61	106.95	101.45
26.55	202.49	174.58	171.55	47.27	49.20	55.50	107.07	101.33
27.05	201.52	174.57	171.53	47.31	49.14	55.29	107.09	101.43
27.55	200.74	174.52	171.59	47.35	48.98	55.07	107.08	101.42
28.05	200.14	174.90	171.60	47.36	48.83	54.87	107.10	101.42
28.55	201.02	175.11	171.67	47.36	48.72	54.68	107.13	101.35
29.05	201.90	175.42	171.80	47.69	48.55	54.51	107.48	101.34
29.55	202.92	175.70	171.98	47.73	48.42	54.35	107.92	101.30
30.05	203.68	176.03	172.11	47.78	48.31	54.22	108.31	101.38
30.55	204.17	176.41	172.28	47.82	48.16	54.09	108.52	101.32
31.05	204.55	176.71	172.28	47.86	48.07	53.98	108.78	101.37
31.55	205.09	176.92	172.32	47.73	47.87	53.85	108.85	101.37
32.05	205.27	177.20	172.36	48.65	47.72	53.74	108.94	101.41
32.55	205.33	177.63	172.46	51.42	47.61	53.59	109.10	101.31
33.05	205.37	177.85	172.50	56.20	47.40	53.46	109.19	101.36
33.55	205.37	178.07	172.63	61.57	47.23	53.27	109.52	101.42
34.05	205.19	178.25	172.74	67.56	47.04	53.11	109.87	101.27
34.55	204.86	178.46	172.87	75.68	46.82	52.92	110.20	102.83
35.05	204.45	178.64	172.96	87.01	46.63	52.83	110.46	102.87
35.55	204.08	178.86	173.05	101.59	46.48	53.63	110.71	102.91
36.05	203.78	179.08	173.09	128.82	46.37	53.52	110.87	102.89
36.55	203.49	179.19	173.15	158.56	46.24	53.37	110.94	102.89

37.05	203.30	179.43	173.21	168.87	46.11	53.38	111.06	102.92
37.55	202.93	179.66	173.19	171.11	45.93	53.32	111.06	102.99
38.05	202.79	179.83	173.18	171.35	46.10	53.21	110.98	103.02
38.55	202.97	180.01	173.13	171.62	45.59	53.31	110.79	103.04
39.05	202.67	180.16	173.35	172.03	45.40	53.11	110.59	103.05
39.55	202.73	180.30	173.01	171.86	45.64	53.03	110.43	103.03
40.05	202.78	180.65	173.05	172.04	45.47	52.85	110.50	102.90
40.55	202.75	180.90	173.12	172.22	45.33	52.55	110.76	102.84
41.05	202.68	181.18	173.22	172.39	45.22	52.32	111.02	102.73
41.55	202.70	181.43	173.33	172.52	45.09	52.08	111.25	102.74
42.05	202.69	181.66	173.42	172.67	44.92	51.93	111.51	102.77
42.55	202.73	181.92	173.48	172.78	44.75	51.66	111.71	102.78
43.05	202.78	182.23	173.53	172.89	44.62	51.50	111.89	102.75
43.55	202.88	182.54	173.61	172.96	44.49	51.23	112.11	102.69
44.05	202.79	182.77	173.67	173.05	44.38	50.93	112.20	102.75
44.55	202.85	183.10	173.69	173.09	44.25	50.86	112.22	102.73
45.05	203.08	183.42	173.69	173.11	43.78	50.63	112.27	102.73
45.55	203.16	183.79	173.66	173.06	43.68	50.31	112.12	103.04
46.05	203.21	184.06	173.66	173.10	43.69	50.05	112.08	102.95
46.55	203.27	184.38	173.72	173.19	43.77	49.80	112.26	102.91
47.05	202.97	184.71	173.79	173.29	44.38	49.56	112.54	102.89
47.55	203.01	185.12	173.90	173.40	44.92	49.35	112.79	102.82
48.05	203.01	185.52	173.98	173.49	45.78	49.12	113.02	102.92
48.55	202.94	185.85	174.03	173.55	46.91	48.90	113.13	102.86
49.05	202.89	186.19	174.07	173.60	48.31	48.69	113.25	102.93
49.55	202.87	186.51	174.11	173.64	49.80	48.48	113.37	102.92
50.05	202.85	186.80	174.16	173.68	51.88	48.26	113.46	102.92
50.55	202.88	187.13	174.17	173.72	55.15	48.07	113.57	102.88
51.05	202.84	187.40	174.21	173.74	60.75	47.86	113.57	102.88
51.55	202.86	187.66	174.21	173.76	68.49	47.65	113.60	102.89
52.05	202.90	187.96	174.21	173.76	77.69	47.46	113.59	102.89
52.55	202.94	188.21	174.19	173.76	87.90	47.26	113.58	102.86
53.05	202.93	188.49	174.20	173.75	100.14	47.01	113.54	101.55
53.55	202.96	188.81	174.18	173.73	116.93	46.82	113.55	102.92
54.05	202.97	189.05	174.18	173.75	134.29	46.64	113.50	102.87
54.55	203.02	189.25	174.22	173.74	147.63	46.45	113.60	102.98
55.05	203.04	189.43	174.26	173.88	158.81	46.32	113.75	102.77
55.55	202.99	189.61	174.35	173.96	164.90	46.18	113.94	102.80
56.05	202.98	189.84	174.43	174.03	168.62	46.01	114.17	102.78

56.55	202.98	190.17	174.45	174.12	170.56	45.90	114.47	102.80
57.05	202.94	190.30	174.61	174.22	171.32	46.15	114.64	102.78
57.55	202.89	190.53	174.60	174.29	172.08	46.00	114.88	102.79
58.05	202.77	190.69	174.74	174.35	172.51	45.89	115.10	102.75
58.55	202.73	190.84	174.80	174.42	172.84	45.78	115.25	102.80
59.05	202.72	190.97	174.85	174.46	173.05	45.64	115.40	102.95
59.55	202.79	191.20	174.85	174.49	173.24	45.49	115.49	102.80
60.05	202.79	191.47	174.93	174.53	173.38	45.38	115.65	102.85
60.55	202.76	191.58	174.97	174.57	173.47	45.25	115.74	102.79
61.05	202.81	191.78	174.99	174.59	173.55	45.14	115.81	101.82
61.55	202.80	191.98	175.02	174.61	173.62	45.00	115.83	102.85
62.05	202.82	192.11	174.99	174.61	173.73	44.85	115.92	102.88
62.55	202.84	192.29	175.03	174.67	173.77	44.72	115.94	103.00
63.05	202.84	192.36	175.05	174.67	173.82	44.63	115.98	102.95
63.55	202.82	192.47	175.07	174.69	173.86	44.54	116.01	102.82
64.05	202.81	192.60	175.07	174.69	173.94	44.46	116.03	102.82
64.55	202.83	192.74	175.09	174.73	173.96	44.35	116.07	102.80
65.05	202.85	193.16	175.05	174.69	173.96	43.89	116.03	102.98
65.55	202.87	193.00	175.04	174.68	173.94	44.14	115.94	103.00
66.05	202.87	193.13	174.99	174.59	173.89	44.01	115.80	103.07
66.55	202.94	193.29	174.88	174.50	173.78	43.93	115.50	102.96
67.05	203.00	193.43	174.77	174.34	173.64	43.86	115.09	102.94
67.55	203.07	193.65	174.60	174.16	173.46	43.86	114.58	102.99
68.05	203.14	193.83	174.36	173.90	173.20	44.03	113.87	102.77
68.55	203.18	194.01	174.04	173.57	172.87	44.34	112.92	103.09
69.05	203.33	194.21	173.68	173.22	172.53	44.88	111.88	103.17
69.55	203.40	194.37	173.33	172.84	172.16	46.05	110.79	103.17
70.05	203.46	194.48	172.93	172.45	171.76	48.36	109.62	101.76
70.55	203.33	194.48	172.50	172.03	171.40	56.11	108.38	101.56
71.05	203.35	194.56	172.11	171.62	170.97	72.16	107.22	100.95
71.55	203.39	194.65	171.64	171.17	170.54	82.88	105.86	101.25
72.05	203.48	194.70	171.32	170.83	170.28	89.04	104.83	101.20
72.55	203.52	194.65	171.03	170.60	170.04	99.77	104.03	101.06
73.05	203.55	194.62	170.84	170.42	169.90	108.66	103.46	100.96
73.55	203.59	194.64	170.68	170.30	169.81	114.98	103.01	100.98
74.05	203.66	194.67	170.59	170.15	169.72	119.90	102.77	100.92
74.54	203.66	194.71	170.55	170.16	170.01	123.75	102.57	100.93
75.05	203.68	194.73	170.50	170.12	169.67	127.90	102.47	100.90
75.55	203.68	194.80	170.50	170.10	169.67	131.57	102.45	100.92

76.05	203.67	194.86	170.50	170.09	169.67	135.40	102.35	100.97
76.55	203.72	194.86	170.47	170.09	169.67	139.21	102.32	101.00
77.05	203.65	194.88	170.47	170.09	169.66	143.91	102.33	100.98
77.55	203.60	194.88	170.45	170.07	169.68	147.78	102.31	100.96
78.05	203.60	194.88	170.45	170.07	169.66	151.63	102.27	100.99
78.55	203.62	194.93	170.40	170.02	169.57	158.83	102.13	100.81
79.05	203.60	194.99	170.35	169.99	169.55	161.14	102.01	101.13
79.54	203.57	195.01	170.37	169.99	169.59	161.39	102.06	101.08
80.05	203.55	194.97	170.38	170.02	169.61	162.15	102.10	101.12
80.55	203.53	195.01	170.40	170.04	169.65	163.25	102.17	101.09
81.05	203.53	195.01	170.40	170.06	169.67	164.26	102.21	101.10
81.55	203.50	195.05	170.44	170.06	169.67	165.56	102.22	101.15
82.05	203.50	195.06	170.44	170.08	169.67	166.53	102.23	101.12
82.55	203.52	195.08	170.42	170.05	169.65	167.29	102.24	101.05
83.05	203.50	195.10	170.41	170.05	169.65	167.82	102.18	101.18
83.55	203.50	195.10	170.41	170.03	169.62	168.14	102.13	101.22
84.05	203.50	195.14	170.41	170.05	169.62	168.38	102.18	101.05
84.54	203.47	195.16	170.41	170.05	169.65	168.56	102.13	101.13
85.05	203.44	195.16	170.39	170.03	169.64	168.70	102.10	101.12
85.55	203.42	195.18	170.39	170.04	169.64	168.81	102.10	101.05
86.05	203.40	195.22	170.41	170.04	169.62	168.90	102.12	101.12
86.55	203.38	195.20	170.40	170.07	169.62	168.97	102.10	101.13
87.05	203.37	195.22	170.38	170.02	169.62	169.05	102.09	101.10
87.55	203.37	195.22	170.40	170.02	169.63	169.10	102.08	100.99
88.05	203.35	195.24	170.40	170.00	169.63	169.16	102.08	100.98
88.55	203.35	195.28	170.38	170.02	169.63	169.21	102.10	100.96
89.05	203.34	195.28	170.42	170.02	169.63	169.16	102.11	100.49
89.55	203.28	195.46	170.15	169.77	169.40	165.52	101.41	101.09
90.05	203.27	195.35	170.24	169.90	169.52	164.55	101.71	101.24
90.55	203.25	195.31	170.30	169.95	169.58	163.51	101.88	101.27
91.05	203.23	195.32	170.37	170.01	169.63	166.99	102.00	101.24
91.55	203.25	195.34	170.39	170.03	169.67	168.39	102.09	101.32
92.05	203.23	195.32	170.39	170.05	169.65	169.02	102.10	101.32
92.54	203.23	195.34	170.41	170.03	169.65	169.31	102.13	101.43
93.05	203.25	195.39	170.41	170.00	169.65	169.42	102.09	101.41
93.55	203.24	195.37	170.36	170.01	169.62	169.44	102.03	101.34
94.05	203.15	195.38	170.37	170.00	169.60	169.42	102.01	101.25
94.55	203.15	195.36	170.34	169.96	169.55	169.39	101.92	101.18
95.05	203.13	195.38	170.30	169.93	169.53	169.39	101.86	101.19

95.55	203.13	195.38	170.29	169.91	169.53	169.39	101.79	101.14
96.05	203.17	195.40	170.27	169.89	169.51	169.37	101.75	101.12
96.55	203.12	195.43	170.25	169.88	169.50	169.39	101.72	101.09
97.05	203.12	195.42	170.25	169.86	169.48	169.37	101.71	100.99
97.55	203.10	195.42	170.24	169.88	169.48	169.41	101.68	101.13
98.05	203.08	195.44	170.26	169.88	169.50	169.41	101.65	101.05
98.55	203.07	195.46	170.26	169.88	169.50	169.41	101.73	100.97
99.05	203.05	195.44	170.24	169.90	169.48	169.45	101.67	101.09
99.55	203.05	195.46	170.28	169.88	169.52	169.47	101.78	100.99
100.05	203.03	195.49	170.28	169.90	169.52	169.49	101.74	101.11
100.55	203.03	195.48	170.28	169.90	169.49	169.36	101.79	100.26
101.05	202.98	195.55	170.21	169.83	169.47	169.50	101.54	100.97
101.55	202.95	195.50	170.24	169.88	169.54	169.56	101.66	101.26
102.05	202.97	195.46	170.28	169.94	169.58	169.58	101.77	101.41
102.55	202.98	195.45	170.32	169.96	169.58	169.63	101.89	101.33
103.05	202.95	195.44	170.32	169.98	169.60	169.62	101.90	101.34
103.55	202.97	195.48	170.34	169.98	169.58	169.62	101.91	101.25
104.05	202.95	195.50	170.34	169.96	169.58	169.62	101.92	101.24
104.55	202.91	195.50	170.30	169.94	169.57	169.62	101.85	101.29
105.05	202.88	195.47	170.30	169.93	169.57	169.62	101.79	101.19
105.55	202.90	195.49	170.29	169.91	169.53	169.62	101.77	101.17
106.05	202.90	195.50	170.27	169.91	169.55	169.60	101.73	101.19
106.55	202.85	195.54	170.25	169.91	169.53	169.60	101.77	101.13
107.05	202.85	195.51	170.25	169.87	169.44	169.35	101.72	99.87
107.55	202.78	195.49	170.22	169.86	169.53	169.70	101.58	101.23
108.05	202.76	195.49	170.33	169.97	169.63	169.75	101.87	101.27
108.55	202.89	195.58	170.38	170.04	169.64	169.73	102.09	101.62
109.05	203.16	195.78	170.26	169.90	169.54	169.64	101.73	101.23
109.55	203.35	195.87	170.31	169.93	169.57	169.70	101.83	101.21
110.05	203.48	195.94	170.33	169.95	169.59	169.74	101.92	101.44
110.55	203.57	196.03	170.33	169.95	169.50	169.49	101.92	100.40
111.05	203.64	196.16	170.26	169.90	169.54	169.68	101.72	101.26
111.55	203.72	196.18	170.30	169.95	169.59	169.72	101.79	101.42
112.05	203.75	196.25	170.32	169.96	169.60	169.74	101.87	101.38
112.55	203.81	196.28	170.33	169.96	169.61	169.74	101.91	101.39
113.05	203.82	196.34	170.32	169.96	169.60	169.74	101.94	101.38
113.55	203.83	196.36	170.32	169.96	169.58	169.72	101.88	101.30
114.05	203.81	196.40	170.28	169.92	169.56	169.71	101.84	101.29
114.55	203.85	196.41	170.28	169.92	169.55	169.69	101.86	101.27

115.05	203.83	196.42	170.27	169.91	169.55	169.71	101.77	101.25
115.54	203.81	196.41	170.25	169.87	169.53	169.69	101.73	101.19
116.05	203.80	196.42	170.25	169.87	169.53	169.69	101.72	101.17
116.55	203.80	196.44	170.23	169.96	169.51	169.69	101.66	101.18
117.05	203.80	196.47	170.31	169.91	169.53	169.68	101.76	101.34
117.55	203.78	196.51	170.27	169.91	169.53	169.71	101.79	101.39
118.05	203.76	196.49	170.26	169.90	169.53	169.73	101.77	101.27
118.55	203.75	196.49	170.27	169.92	169.54	169.74	101.82	101.31
119.05	203.73	196.55	170.20	169.83	169.47	169.70	101.64	101.24
119.55	203.69	196.50	170.26	169.90	169.58	169.77	101.74	101.33
120.05	203.68	196.44	170.29	169.95	169.61	169.83	101.86	101.52
120.55	203.66	196.46	170.31	169.97	169.61	169.79	101.92	101.52
121.05	203.66	196.45	170.31	169.95	169.59	169.79	101.89	101.48
121.55	203.66	196.48	170.32	169.96	169.58	169.76	101.89	101.51
122.05	203.66	196.52	170.32	169.94	169.58	169.76	101.91	101.42
122.55	203.66	196.54	170.28	169.92	169.54	169.76	101.85	101.32
123.05	203.65	196.52	170.28	169.92	169.54	169.74	101.85	101.35
123.55	203.61	196.56	170.21	169.85	169.51	169.74	101.65	101.30
124.05	203.61	196.54	170.29	169.94	169.62	169.84	101.85	101.38
124.55	203.63	196.53	170.32	169.96	169.62	169.82	101.95	101.59
125.05	203.65	196.56	170.33	169.96	169.60	169.80	101.96	101.52
125.55	203.58	196.55	170.29	169.93	169.59	169.79	101.93	101.39
126.05	203.57	196.58	170.29	169.95	169.57	169.77	101.89	101.43
126.55	203.57	196.62	170.29	169.93	169.55	169.75	101.87	101.37
127.05	203.59	196.60	170.28	169.92	169.56	169.75	101.84	101.38
127.55	203.55	196.60	170.28	169.90	169.56	169.74	101.88	101.34
128.05	203.52	196.62	170.26	169.90	169.54	169.74	101.84	101.37
128.55	203.54	196.62	170.26	169.90	169.54	169.76	101.86	101.33
129.05	203.56	196.61	170.26	169.90	169.54	169.76	101.80	101.30
129.55	203.57	196.64	170.28	169.89	169.54	169.74	101.78	101.31
130.05	203.56	196.63	170.25	169.89	169.53	169.74	101.80	101.32
130.55	203.53	196.63	170.25	169.89	169.55	169.76	101.77	101.30
131.05	203.51	196.69	170.27	169.89	169.53	169.75	101.84	101.29
131.55	203.53	196.69	170.25	169.89	169.55	169.78	101.83	101.34
132.05	203.53	196.65	170.25	169.89	169.55	169.77	101.82	101.37
132.55	203.51	196.65	170.26	169.91	169.54	169.77	101.82	101.31
133.05	203.51	196.67	170.24	169.91	169.55	169.77	101.84	101.35
133.54	203.53	196.67	170.26	169.90	169.55	169.77	101.83	101.30
134.05	203.51	196.69	170.26	169.90	169.56	169.75	101.81	101.30

134.55	203.50	196.69	170.26	169.86	169.43	169.49	101.84	100.37
135.05	203.47	196.73	170.19	169.87	169.54	169.85	101.61	101.31
135.55	203.47	196.65	170.32	169.98	169.65	169.92	101.91	101.48
136.05	203.52	196.66	170.34	170.00	169.64	169.87	102.04	101.65
136.55	203.52	196.70	170.34	169.96	169.64	169.87	102.06	101.60
137.05	203.51	196.74	170.32	169.98	169.62	169.84	102.07	101.52
137.55	203.47	196.78	170.34	169.95	169.60	169.84	102.07	101.46
138.05	203.47	196.76	170.31	169.95	169.59	169.80	101.95	101.44
138.55	203.48	196.78	170.29	169.95	169.57	169.79	101.94	101.37
139.05	203.44	196.82	170.19	169.84	169.48	169.79	101.60	101.32
139.55	203.46	196.73	170.26	169.90	169.59	169.85	101.81	101.43
140.05	203.45	196.71	170.31	169.97	169.63	169.88	101.98	101.53
140.55	203.48	196.75	170.33	170.05	169.63	169.88	102.04	101.58
141.05	203.48	196.79	170.33	169.98	169.62	169.87	102.06	101.58
141.55	203.49	196.81	170.32	169.96	169.63	169.83	102.02	101.54
142.05	203.47	196.79	170.30	169.96	169.60	169.83	101.98	101.43
142.55	203.47	196.81	170.30	169.94	169.58	169.82	101.91	101.39
143.05	203.44	196.81	170.27	169.93	169.55	169.80	101.84	101.31
143.55	203.49	196.83	170.24	169.88	169.53	169.79	101.80	101.30
144.05	203.48	196.83	170.24	169.90	169.53	169.77	101.76	101.28
144.55	203.46	196.85	170.22	169.84	169.43	169.56	101.77	100.17
145.05	203.44	196.82	170.22	169.90	169.57	169.84	101.75	101.33
145.55	203.45	196.82	170.35	170.03	169.63	169.90	101.91	101.46
146.05	203.43	196.82	170.32	169.97	169.63	169.88	102.00	101.51
146.55	203.45	196.84	170.34	169.98	169.63	169.87	102.03	101.63
147.05	203.42	196.84	170.32	169.96	169.60	169.87	101.99	101.42
147.55	203.40	196.83	170.29	169.93	169.58	169.84	101.95	101.52
148.05	203.40	196.87	170.29	169.93	169.57	169.80	101.89	101.42
148.55	203.44	196.89	170.31	169.91	169.55	169.79	101.82	101.51
149.05	203.41	196.89	170.26	169.90	169.54	169.77	101.82	101.29
149.55	203.39	196.89	170.26	169.88	169.54	169.77	101.74	101.40
150.05	203.39	196.87	170.24	169.88	169.54	169.77	101.75	101.37
150.55	203.41	196.89	170.23	169.87	169.52	169.78	101.72	101.34
151.05	203.40	196.89	170.21	169.89	169.53	169.76	101.73	101.33
151.54	203.38	196.92	170.23	169.87	169.51	169.76	101.73	101.32
152.05	203.38	196.90	170.23	169.85	169.51	169.78	101.79	101.30
152.55	203.38	196.90	170.21	169.87	169.53	169.78	101.74	101.31
153.05	203.40	196.90	170.24	169.88	169.53	169.82	101.76	101.32
153.55	203.39	196.92	170.29	169.84	169.57	169.81	101.82	101.33

154.05	203.35	196.94	170.26	169.92	169.57	169.83	101.84	101.42
154.55	203.36	196.94	170.28	169.92	169.58	169.85	101.86	101.39
155.05	203.36	196.97	170.28	169.92	169.58	169.83	101.90	101.38
155.55	203.40	196.95	170.28	169.94	169.58	169.85	101.90	101.36
156.05	203.40	196.99	170.26	169.92	169.56	169.81	101.90	101.36
156.55	203.35	196.99	170.29	169.91	169.58	169.84	101.89	101.33
157.05	203.36	196.97	170.29	169.93	169.59	169.84	101.87	101.31
157.55	203.35	196.98	170.29	169.93	169.59	169.84	101.88	101.26
158.05	203.35	196.98	170.27	169.91	169.57	169.84	101.89	101.37
158.55	203.32	196.98	170.28	169.90	169.56	169.84	101.87	101.35
159.05	203.36	197.02	170.19	169.77	169.32	169.52	101.68	100.34
159.55	203.32	196.97	170.23	169.87	169.58	169.90	101.70	101.30
160.05	203.34	196.95	170.30	169.98	169.67	169.92	101.94	101.55
160.55	203.36	196.95	170.34	170.00	169.64	169.94	102.03	101.57
161.05	203.35	196.99	170.34	169.98	169.64	169.91	102.04	101.57
161.55	203.33	196.99	170.31	169.96	169.62	169.87	102.00	101.52
162.05	203.35	196.99	170.31	169.95	169.59	169.86	101.97	101.50
162.55	203.35	197.03	170.27	169.91	169.57	169.84	101.94	101.35
163.05	203.35	197.07	170.28	169.92	169.56	169.83	101.84	101.40
163.55	203.32	197.07	170.26	169.90	169.56	169.81	101.85	101.40
164.05	203.30	197.04	170.26	169.88	169.54	169.79	101.83	101.39
164.55	203.34	197.07	170.23	169.89	169.52	169.80	101.85	101.53
165.05	203.33	197.08	170.23	169.94	169.53	169.82	101.86	101.34
165.55	203.31	197.10	170.29	169.89	169.55	169.80	101.80	101.34
166.05	203.31	197.06	170.22	169.88	169.53	169.80	101.77	101.31
166.55	203.33	197.06	170.24	169.88	169.53	169.80	101.81	101.24
167.05	203.32	197.09	170.24	169.88	169.54	169.81	101.81	101.51
167.55	203.32	197.07	170.24	169.92	169.56	169.81	101.79	101.46
168.05	203.34	197.11	170.22	169.88	169.56	169.83	101.84	101.32
168.55	203.32	197.09	170.26	169.89	169.56	169.83	101.87	101.38
169.05	203.29	197.09	170.25	169.91	169.58	169.83	101.89	101.40
169.55	203.31	197.10	170.27	169.91	169.55	169.84	101.89	101.37
170.05	203.31	197.12	170.27	169.86	169.57	169.86	101.93	101.30
170.55	203.33	197.12	170.27	169.91	169.57	169.86	101.90	101.34
171.05	203.30	197.10	170.27	169.91	169.59	169.86	101.91	101.39
171.55	203.30	197.12	170.26	169.92	169.58	169.85	101.88	101.35
172.04	203.30	197.13	170.28	169.92	169.61	169.85	101.94	101.38
172.55	203.29	197.13	170.26	169.92	169.56	169.87	101.91	101.34
173.05	203.25	197.18	170.14	169.76	169.44	169.71	101.58	101.44

173.55	203.26	197.13	170.18	169.84	169.51	169.80	101.68	101.48
174.05	203.28	197.13	170.23	169.89	169.57	169.86	101.83	101.70
174.55	203.30	197.14	170.27	169.95	169.61	169.89	101.95	101.62
175.05	203.30	197.17	170.31	169.97	169.61	169.90	101.98	101.56
175.55	203.30	197.19	170.31	169.97	169.61	169.88	102.00	101.57
176.05	203.28	197.18	170.31	169.94	169.59	169.88	101.98	101.54
176.55	203.32	197.16	170.28	169.92	169.58	169.85	101.96	101.47
177.05	203.32	197.18	170.28	169.91	169.56	169.85	101.93	101.49
177.55	203.31	197.18	170.27	169.91	169.56	169.84	101.86	101.45
178.05	203.31	197.19	170.25	169.91	169.55	169.82	101.90	101.41
178.55	203.28	197.17	170.24	169.89	169.55	169.82	101.85	101.42
179.05	203.32	197.19	170.22	169.86	169.52	169.82	101.79	101.34
179.55	201.57	194.76	169.47	169.38	169.25	169.63	112.57	102.77
180.05	198.84	191.63	168.39	168.41	168.35	167.00	130.17	100.80

Table B2 – Temperature and pressure data for run 4.

Time, min	T_1, °C	T_2, °C	T_3, °C	T_4, °C	T_5, °C	T_6, °C	P_{inj}, psi	P_{out}, psi
0.05	129.04	69.69	49.58	44.42	46.89	49.71	117.22	101.75
0.55	180.69	161.75	49.64	44.44	46.97	49.92	98.12	100.69
1.05	196.98	141.61	49.61	44.47	46.95	49.97	97.89	100.53
1.55	204.00	159.03	49.67	44.46	47.00	50.09	97.77	100.47
2.05	205.76	165.08	49.71	44.48	46.98	50.23	97.73	100.32
2.55	205.14	165.77	49.75	44.50	46.99	50.33	97.63	100.21
3.05	203.45	167.13	49.78	44.53	46.97	50.41	97.60	100.21
3.55	201.46	167.94	49.77	44.53	46.96	50.51	97.74	100.01
4.05	199.50	168.36	49.79	44.54	46.99	50.61	97.66	100.17
4.55	198.16	168.24	49.80	44.54	46.95	50.69	97.51	99.95
5.05	197.15	168.43	49.80	44.53	46.96	50.77	97.70	99.90
5.55	195.86	168.70	49.81	44.55	46.98	50.85	97.70	100.05
6.05	195.02	168.49	49.83	44.54	46.95	50.92	97.87	100.95
6.55	195.19	168.71	49.80	44.55	46.95	50.98	97.85	100.27
7.05	195.46	169.01	49.82	44.55	46.96	51.04	97.96	100.14
7.55	194.95	169.67	49.85	44.56	46.93	51.11	98.11	100.10
8.05	194.99	169.39	49.81	44.53	46.95	51.15	98.10	100.06
8.55	195.30	169.76	49.82	44.53	46.96	51.21	98.23	100.28
9.05	195.66	170.01	49.81	44.54	46.96	51.29	98.49	100.22
9.55	195.88	170.11	49.83	44.54	46.95	51.32	98.61	100.43
10.05	196.07	169.90	50.16	44.55	46.95	51.36	98.76	100.22
10.55	196.12	169.97	50.30	44.53	46.96	51.42	99.01	100.23
11.05	196.20	170.00	50.49	44.56	46.96	51.47	99.01	100.18
11.55	196.19	170.09	50.67	44.54	46.99	51.51	99.19	100.23
12.05	196.43	170.19	50.49	44.55	46.98	51.55	99.54	100.34
12.55	196.11	170.54	50.72	44.50	47.00	51.58	99.68	100.32
13.05	196.81	170.25	51.20	44.54	46.99	51.66	99.62	101.09
13.55	197.64	170.37	51.38	44.56	46.99	51.70	99.94	100.40
14.05	197.95	170.44	51.56	44.53	47.00	51.75	100.16	100.34
14.55	198.08	170.56	51.73	44.56	46.98	51.75	100.43	100.46
15.05	198.23	170.70	51.97	44.54	46.93	51.78	100.82	100.48
15.55	198.43	170.78	52.18	44.53	46.99	51.82	101.07	101.23
16.05	198.49	170.93	52.38	44.51	46.94	51.90	101.43	101.21
16.55	198.50	171.10	52.63	44.50	46.91	51.94	101.82	100.66
17.05	198.79	171.23	52.64	44.51	46.93	52.03	102.16	100.73
17.55	198.62	171.34	53.36	44.51	46.94	52.01	102.45	100.84

18.05	198.58	171.47	53.77	44.58	46.95	52.06	102.80	100.92
18.55	198.66	171.62	54.25	44.58	46.93	52.08	103.17	100.95
19.05	198.67	171.77	54.79	44.57	46.94	52.10	103.53	101.14
19.55	198.60	171.88	55.40	44.57	46.98	52.05	103.93	101.23
20.05	198.51	172.12	56.07	44.52	46.95	52.08	104.50	101.18
20.55	198.47	172.31	56.84	44.51	46.99	52.08	104.91	101.29
21.05	198.43	172.40	57.64	44.53	47.03	52.07	105.12	101.36
21.55	198.31	172.55	58.54	44.59	47.02	52.07	105.49	101.40
22.05	198.21	172.65	59.60	44.62	47.01	52.10	105.73	101.49
22.55	198.16	172.78	61.22	44.66	46.98	52.14	105.92	101.46
23.05	198.17	172.84	65.27	44.72	46.96	52.17	106.05	101.52
23.55	198.10	172.97	75.96	44.77	46.91	52.21	106.29	101.57
24.05	198.14	173.12	94.63	44.89	46.92	52.27	106.72	101.62
24.55	198.11	173.39	112.18	44.95	46.90	52.30	107.34	101.47
25.05	197.99	173.56	131.61	45.00	46.89	52.30	107.69	101.51
25.55	197.85	173.69	156.32	45.08	46.91	52.31	107.92	101.65
26.05	197.82	173.80	169.50	45.12	46.92	52.29	108.13	101.51
26.55	197.85	173.92	171.15	45.49	46.87	52.26	108.25	101.61
27.05	197.89	174.21	171.89	45.57	46.89	52.19	108.56	101.55
27.55	198.02	174.54	172.33	45.65	46.95	52.14	109.19	101.52
28.05	197.95	174.79	172.62	45.76	46.94	52.13	109.61	101.48
28.55	198.01	175.00	172.79	45.86	46.98	52.04	109.78	101.56
29.05	197.98	175.16	172.90	45.92	46.99	51.95	109.93	101.54
29.55	198.07	175.31	172.96	45.71	46.95	51.87	109.97	101.69
30.05	197.83	175.46	173.03	46.16	46.92	51.78	110.03	102.97
30.55	197.85	175.68	173.11	46.26	46.77	51.66	110.20	102.99
31.05	197.89	176.01	173.22	46.34	46.70	51.53	110.48	102.98
31.55	197.89	176.37	173.41	46.40	46.63	51.32	110.99	103.02
32.05	197.90	176.59	173.57	46.46	46.56	51.14	111.35	102.85
32.55	197.92	176.88	173.68	46.47	46.45	51.03	111.66	102.88
33.05	197.73	177.19	174.07	46.17	46.30	50.84	111.83	102.86
33.55	197.66	177.54	173.82	46.53	46.19	50.67	112.04	102.88
34.05	197.97	177.81	173.91	46.69	46.08	50.51	112.27	102.87
34.55	198.13	178.25	173.97	47.55	45.93	50.43	112.40	102.85
35.05	198.28	178.52	173.99	49.56	45.74	50.53	112.49	103.00
35.55	198.43	178.80	174.05	52.04	45.58	50.58	112.54	102.89
36.05	198.49	179.12	174.15	56.01	45.43	50.49	112.74	102.89
36.55	198.55	179.49	174.28	61.41	45.28	50.40	113.16	102.82
37.05	198.60	179.85	174.37	68.77	45.11	50.23	113.45	102.85

37.55	198.61	180.14	174.43	77.01	44.91	50.02	113.59	102.94
38.05	198.59	180.54	174.43	84.75	44.70	49.78	113.60	102.95
38.54	198.53	180.85	174.44	92.42	44.44	49.50	113.59	103.10
39.05	198.50	181.19	174.42	102.00	44.23	49.20	113.55	103.16
39.55	198.52	181.58	174.43	120.48	44.04	48.94	113.60	103.18
40.05	198.50	181.92	174.40	150.61	43.91	48.67	113.50	103.32
40.55	198.52	182.30	174.40	166.50	43.77	48.39	113.42	103.41
41.05	198.56	182.67	174.35	171.42	43.58	48.15	113.30	103.31
41.55	198.62	183.04	174.41	172.55	43.79	47.90	113.41	103.20
42.05	198.61	183.41	174.47	173.10	43.63	47.64	113.58	103.16
42.55	198.58	183.81	174.49	173.35	43.48	47.40	113.64	103.13
43.05	198.60	184.17	174.53	173.52	43.37	47.13	113.68	103.10
43.54	198.58	184.50	174.53	173.92	42.87	46.93	113.69	103.09
44.05	198.62	184.81	174.54	173.67	43.11	46.72	113.71	103.03
44.55	198.66	185.13	174.56	173.71	42.98	46.53	113.73	103.01
45.05	198.72	185.42	174.53	173.72	42.85	46.33	113.68	100.60
45.55	198.67	185.73	174.44	173.65	42.74	46.18	113.39	101.81
46.05	198.66	185.95	174.33	173.58	42.64	46.05	113.06	102.10
46.55	198.77	186.19	174.28	173.56	42.65	45.88	112.87	102.19
47.05	198.81	186.37	174.32	173.64	42.65	45.71	112.92	102.23
47.55	198.81	186.57	174.36	173.70	42.89	45.58	113.08	102.23
48.05	198.87	186.75	174.38	173.74	43.23	45.45	113.11	102.22
48.55	198.90	187.06	174.42	173.77	43.77	45.30	113.22	102.27
49.05	198.77	187.23	174.46	173.80	44.46	45.17	113.29	102.19
49.55	198.64	187.37	174.46	173.82	45.65	45.02	113.31	102.25
50.05	198.57	187.52	174.47	173.84	47.43	44.89	113.30	102.17
50.55	198.56	187.70	174.47	173.82	50.13	44.74	113.27	102.16
51.05	198.53	187.85	174.46	173.85	54.15	44.65	113.27	102.13
51.55	198.53	188.00	174.50	173.90	59.05	44.52	113.33	102.02
52.05	198.57	188.14	174.55	173.94	65.28	44.47	113.51	101.39
52.55	198.54	188.32	174.59	173.98	72.49	44.33	113.65	101.57
53.05	198.54	188.43	174.63	174.06	79.31	44.22	113.73	101.68
53.55	198.56	188.60	174.65	174.08	85.19	44.13	113.81	101.68
54.05	198.53	188.67	174.69	174.12	90.04	44.04	113.88	101.75
54.55	198.46	188.80	174.71	174.14	95.62	43.93	113.95	101.84
55.05	198.41	188.95	174.72	174.16	101.61	43.81	113.96	101.85
55.55	198.41	189.06	174.72	174.14	108.64	43.70	113.94	101.89
56.05	198.45	189.13	174.72	174.16	118.47	43.61	113.97	101.94
56.55	198.38	189.28	174.72	174.17	130.86	43.48	113.97	101.93

57.05	198.38	189.37	174.73	174.19	144.64	43.35	113.99	101.93
57.55	198.38	189.46	174.71	174.19	155.25	43.23	113.96	101.95
58.05	198.35	189.57	174.77	174.17	164.58	43.09	114.01	101.96
58.55	198.26	189.65	174.71	174.18	169.12	42.95	113.96	102.00
59.05	198.20	189.70	174.74	174.18	171.12	42.84	113.91	101.99
59.55	198.25	189.81	174.74	174.22	172.24	42.75	113.97	101.85
60.05	198.31	189.91	174.76	174.24	172.46	43.06	114.08	101.82
60.55	198.29	189.98	174.78	174.26	172.84	42.92	114.07	101.46
61.05	198.29	190.03	174.81	174.27	173.05	42.83	114.10	101.52
61.54	198.31	190.09	174.82	174.30	173.23	42.74	114.17	101.55
62.05	198.30	190.18	174.84	174.35	173.35	42.68	114.24	101.56
62.55	198.32	190.24	174.88	174.34	173.44	42.61	114.33	101.60
63.05	198.30	190.29	174.84	174.39	173.51	42.48	114.38	101.53
63.55	198.36	190.39	174.90	174.47	173.60	42.36	114.50	101.51
64.05	198.45	190.46	174.97	174.47	173.68	42.27	114.58	101.50
64.55	198.42	190.52	174.99	174.49	173.73	42.20	114.65	101.52
65.05	198.45	190.59	175.01	174.53	173.79	42.16	114.77	101.51
65.55	198.42	190.68	175.07	174.58	173.83	42.12	114.88	101.56
66.05	198.37	190.70	175.11	174.58	173.88	42.07	114.95	101.60
66.54	198.32	190.74	175.11	174.60	173.92	41.99	114.99	101.61
67.05	198.25	190.78	175.11	174.59	173.92	41.96	115.04	101.66
67.55	198.25	190.81	175.09	174.59	173.92	41.90	115.00	100.49
68.05	198.21	190.90	175.08	174.54	173.89	41.86	114.85	101.27
68.55	198.20	190.90	175.00	174.52	173.85	41.83	114.75	101.45
69.05	198.25	191.00	174.97	174.47	173.82	41.96	114.61	101.58
69.55	198.15	191.05	174.95	174.43	173.79	42.12	114.51	101.66
70.05	198.09	191.09	174.88	174.38	173.75	42.39	114.32	101.80
70.55	198.08	191.11	174.81	174.31	173.68	42.73	114.10	101.88
71.05	198.06	191.15	174.72	174.20	173.57	43.31	113.84	102.06
71.55	198.04	191.24	174.62	174.08	173.47	44.25	113.53	102.21
72.05	198.06	191.31	174.46	173.94	173.31	45.26	113.08	102.40
72.55	198.15	191.44	174.28	173.72	173.06	46.58	112.50	102.62
73.05	198.15	191.53	174.05	173.49	172.84	48.47	111.84	102.39
73.55	198.19	191.64	173.73	173.13	172.41	51.98	110.81	100.89
74.05	198.27	191.74	173.29	172.70	172.02	58.50	109.55	101.31
74.55	198.41	191.87	172.90	172.31	171.64	67.30	108.39	101.65
75.05	198.68	191.98	172.52	171.91	171.28	78.65	107.18	101.97
75.55	198.84	192.07	172.13	171.55	170.90	93.32	106.10	101.17
76.05	198.99	192.14	171.77	171.21	170.62	110.87	105.12	101.18

76.55	199.02	192.20	171.52	170.96	170.37	128.88	104.34	101.88
77.05	199.08	192.22	171.32	170.76	170.19	145.59	103.70	100.87
77.55	199.18	192.22	171.11	170.57	170.03	157.73	103.12	100.68
78.05	199.20	192.25	170.93	170.37	169.87	164.36	102.59	101.15
78.55	199.21	192.27	170.80	170.21	169.69	166.91	102.17	100.23
79.05	199.13	192.27	170.53	169.99	169.44	167.91	101.46	99.36
79.55	199.17	192.27	170.36	169.83	169.35	168.21	100.93	99.59
80.05	199.28	192.28	170.25	169.76	169.31	168.41	100.68	99.62
80.55	199.19	192.26	170.25	169.75	169.30	168.56	100.63	99.59
81.05	199.12	192.22	170.25	169.73	169.28	168.63	100.62	99.64
81.55	199.03	192.19	170.23	169.73	169.30	168.70	100.56	100.57
82.05	199.00	192.17	170.23	169.77	169.28	168.76	100.55	99.66
82.55	198.87	192.14	170.22	169.71	169.30	168.83	100.56	100.46
83.05	198.86	192.12	170.24	169.71	169.26	168.89	100.58	100.54
83.55	198.80	192.10	170.27	169.73	169.30	168.92	100.60	99.63
84.05	198.71	192.10	170.24	169.73	169.32	168.98	100.63	99.67
84.55	198.61	192.09	170.26	169.75	169.32	169.01	100.68	100.54
85.05	198.57	192.07	170.24	169.73	169.32	169.07	100.61	99.82
85.55	198.48	192.07	170.26	169.74	169.32	169.10	100.63	100.71
86.05	198.43	192.05	170.26	169.75	169.32	169.11	100.66	99.82
86.55	198.36	192.05	170.26	169.75	169.29	169.12	100.68	99.80
87.05	198.32	192.07	170.26	169.75	169.34	169.14	100.67	100.56
87.55	198.27	192.07	170.26	169.76	169.34	169.18	100.70	99.77
88.05	198.24	192.07	170.26	169.76	169.32	169.16	100.70	99.77
88.55	198.22	192.07	170.28	169.76	169.32	169.20	100.71	99.87
89.05	198.22	192.07	170.26	169.76	169.32	169.22	100.72	100.55
89.55	198.11	192.11	170.23	169.69	169.22	169.06	100.55	99.50
90.05	198.11	192.13	170.17	169.65	169.24	169.15	100.49	99.80
90.55	198.09	192.13	170.19	169.67	169.26	169.18	100.51	99.89
91.05	198.08	192.15	170.23	169.71	169.29	169.24	100.60	99.94
91.55	198.04	192.15	170.23	169.74	169.33	169.28	100.64	99.95
92.05	198.01	192.13	170.25	169.76	169.33	169.29	100.69	99.92
92.55	198.03	192.15	170.27	169.73	169.33	169.28	100.69	100.06
93.05	198.01	192.17	170.23	169.75	169.35	169.30	100.73	99.82
93.55	197.94	192.15	170.27	169.75	169.33	169.30	100.71	99.76
94.05	197.87	192.17	170.25	169.75	169.32	169.30	100.69	99.86
94.55	197.94	192.16	170.24	169.73	169.32	169.30	100.62	100.54
95.05	197.86	192.19	170.26	169.73	169.30	169.30	100.64	99.73
95.55	197.84	192.19	170.24	169.73	169.32	169.32	100.64	99.76

96.05	197.82	192.21	170.22	169.72	169.29	169.30	100.63	99.87
96.55	197.86	192.23	170.24	169.74	169.32	169.31	100.66	99.75
97.05	197.86	192.25	170.22	169.72	169.31	169.31	100.60	99.84
97.55	197.86	192.27	170.21	169.72	169.31	169.31	100.55	99.81
98.05	197.99	192.31	170.21	169.70	169.29	169.31	100.57	100.48
98.55	197.99	192.33	170.19	169.69	169.27	169.31	100.52	100.53
99.05	197.93	192.36	170.21	169.69	169.29	169.31	100.55	99.72
99.55	197.90	192.40	170.21	169.69	169.17	169.04	100.57	98.90
100.05	197.92	192.42	170.10	169.64	169.20	169.28	100.30	99.81
100.55	197.94	192.44	170.12	169.66	169.26	169.31	100.36	99.89
101.05	197.96	192.46	170.18	169.67	169.28	169.33	100.46	99.96
101.55	197.97	192.49	170.20	169.75	169.28	169.35	100.56	100.00
102.05	198.01	192.49	170.22	169.73	169.32	169.42	100.55	100.00
102.55	198.03	192.51	170.20	169.71	169.32	169.39	100.56	100.71
103.05	198.05	192.53	170.24	169.73	169.32	169.37	100.63	100.68
103.55	197.94	192.55	170.22	169.72	169.32	169.37	100.60	100.63
104.05	197.91	192.55	170.22	169.72	169.30	169.38	100.62	100.63
104.55	197.87	192.57	170.22	169.70	169.30	169.36	100.64	99.78
105.05	197.84	192.57	170.20	169.65	169.30	169.38	100.58	99.85
105.55	197.84	192.61	170.22	169.72	169.25	169.38	100.61	99.84
106.05	197.82	192.63	170.22	169.70	169.31	169.38	100.60	99.81
106.55	197.84	192.63	170.19	169.70	169.29	169.38	100.56	100.54
107.05	197.88	192.63	170.19	169.69	169.27	169.38	100.54	99.80
107.55	197.87	192.67	170.19	169.69	169.33	169.37	100.57	99.90
108.05	197.83	192.67	170.20	169.69	169.30	169.39	100.57	99.82
108.55	197.85	192.67	170.21	169.71	169.31	169.42	100.58	99.79
109.05	197.85	192.69	170.20	169.69	169.30	169.39	100.57	100.42
109.55	197.82	192.73	170.22	169.71	169.30	169.41	100.60	100.62
110.05	197.78	192.75	170.11	169.59	169.14	169.19	100.37	99.61
110.54	197.82	192.77	170.10	169.59	169.21	169.32	100.31	100.71
111.05	197.91	192.79	170.13	169.63	169.25	169.29	100.40	99.66
111.55	197.82	192.79	170.10	169.59	169.20	169.31	100.35	100.54
112.05	197.83	192.83	170.15	169.63	169.24	169.36	100.43	100.56
112.55	197.85	192.87	170.16	169.65	169.27	169.40	100.46	100.76
113.04	197.85	192.85	170.19	169.67	169.29	169.44	100.57	99.96
113.55	197.81	192.85	170.19	169.71	169.35	169.44	100.59	100.80
114.05	197.80	192.84	170.20	169.69	169.32	169.42	100.60	100.01
114.55	197.73	192.86	170.22	169.71	169.34	169.44	100.67	100.72
115.05	197.71	192.82	170.20	169.72	169.30	169.43	100.60	100.78

115.55	197.68	192.88	170.22	169.70	169.32	169.43	100.62	100.86
116.05	197.68	192.88	170.21	169.67	169.34	169.43	100.63	99.89
116.55	197.66	192.86	170.21	169.69	169.29	169.42	100.56	100.62
117.05	197.63	192.87	170.17	169.69	169.29	169.42	100.54	99.83
117.55	197.63	192.89	170.19	169.69	169.30	169.42	100.54	99.80
118.05	197.67	192.91	170.20	169.62	169.23	169.19	100.54	99.61
118.55	197.64	192.93	170.09	169.59	169.23	169.39	100.29	99.75
119.05	197.57	192.91	170.11	169.61	169.19	169.37	100.32	99.65
119.55	197.57	192.93	170.09	169.63	169.25	169.41	100.39	99.97
120.05	197.61	192.95	170.13	169.63	169.25	169.43	100.38	99.86
120.55	197.61	192.95	170.15	169.67	169.31	169.43	100.48	100.31
121.05	197.59	192.97	170.19	169.69	169.31	169.45	100.56	100.72
121.55	197.65	193.01	170.19	169.67	169.31	169.44	100.52	100.67
122.05	197.65	193.01	170.20	169.76	169.32	169.44	100.53	99.81
122.55	197.58	193.02	170.20	169.69	169.32	169.43	100.55	99.92
123.05	197.53	193.04	170.20	169.70	169.30	169.45	100.58	99.98
123.55	197.55	193.00	170.22	169.70	169.30	169.45	100.55	99.84
124.05	197.57	193.06	170.19	169.72	169.31	169.45	100.52	99.80
124.55	197.58	193.06	170.19	169.69	169.31	169.44	100.55	100.54
125.05	197.56	193.05	170.19	169.69	169.29	169.46	100.51	100.04
125.55	197.58	193.10	170.21	169.69	169.31	169.44	100.53	100.66
126.05	197.55	193.12	170.18	169.69	169.31	169.46	100.50	100.57
126.55	197.55	193.12	170.18	169.68	169.32	169.44	100.55	100.47
127.05	197.57	193.13	170.18	169.70	169.30	169.45	100.54	99.81
127.55	197.53	193.18	170.20	169.70	169.29	169.47	100.54	100.61
128.05	197.57	193.15	170.17	169.68	169.29	169.47	100.46	100.38
128.55	197.57	193.17	170.15	169.67	169.29	169.45	100.47	100.55
129.05	197.59	193.21	170.17	169.67	169.29	169.45	100.45	100.52
129.55	197.61	193.21	170.16	169.67	169.29	169.44	100.48	99.79
130.05	197.54	193.23	170.07	169.55	169.15	169.33	100.18	99.56
130.55	197.58	193.23	170.09	169.60	169.21	169.41	100.22	100.48
131.05	197.62	193.23	170.15	169.64	169.28	169.46	100.33	100.59
131.55	197.66	193.29	170.15	169.66	169.30	169.46	100.40	100.64
132.05	197.63	193.29	170.19	169.68	169.32	169.48	100.48	99.87
132.55	197.61	193.31	170.19	169.74	169.34	169.49	100.52	99.80
133.05	197.63	193.31	170.17	169.69	169.33	169.49	100.48	99.79
133.55	197.58	193.31	170.19	169.71	169.33	169.49	100.56	99.94
134.05	197.51	193.33	170.19	169.69	169.31	169.49	100.53	100.49
134.55	197.56	193.34	170.18	169.69	169.31	169.48	100.52	100.42

135.05	197.49	193.37	170.07	169.57	169.17	169.30	100.21	100.29
135.55	197.51	193.36	170.07	169.59	169.23	169.39	100.15	100.40
136.05	197.53	193.34	170.08	169.61	169.25	169.47	100.28	99.77
136.55	197.61	193.36	170.13	169.65	169.27	169.47	100.35	99.93
137.05	197.63	193.40	170.15	169.67	169.31	169.51	100.42	99.95
137.55	197.59	193.40	170.19	169.69	169.31	169.47	100.48	100.51
138.05	197.52	193.42	170.12	169.58	169.24	169.42	100.35	99.73
138.55	197.58	193.42	170.12	169.64	169.26	169.46	100.31	99.89
139.05	197.58	193.42	170.14	169.66	169.28	169.46	100.33	99.91
139.55	197.57	193.43	170.13	169.66	169.30	169.48	100.40	99.85
140.05	197.57	193.45	170.18	169.68	169.30	169.50	100.43	99.96
140.55	197.59	193.49	170.19	169.66	169.32	169.48	100.51	99.89
141.05	197.55	193.47	170.19	169.68	169.33	169.49	100.52	99.99
141.55	197.50	193.47	170.19	169.70	169.33	169.51	100.57	99.96
142.05	197.54	193.49	170.19	169.71	169.33	169.49	100.55	99.95
142.55	197.51	193.51	170.18	169.71	169.33	169.51	100.56	99.92
143.05	197.49	193.52	170.20	169.69	169.35	169.49	100.51	99.89
143.55	197.53	193.53	170.20	169.68	169.32	169.48	100.53	99.91
144.05	197.53	193.55	170.16	169.70	169.32	169.48	100.55	99.82
144.55	197.51	193.56	170.20	169.70	169.32	169.50	100.56	99.77
145.05	197.50	193.56	170.19	169.70	169.32	169.49	100.53	99.83
145.55	197.52	193.58	170.19	169.70	169.32	169.47	100.54	100.07
146.05	197.50	193.58	170.19	169.69	169.34	169.49	100.49	99.82
146.55	197.49	193.58	170.19	169.69	169.33	169.47	100.53	99.80
147.05	197.49	193.60	170.18	169.67	169.31	169.49	100.48	99.83
147.55	197.55	193.64	170.18	169.68	169.32	169.48	100.52	99.77
148.05	197.49	193.63	170.20	169.68	169.32	169.48	100.55	99.92
148.55	197.48	193.65	170.18	169.72	169.32	169.50	100.55	99.84
149.04	197.48	193.67	170.19	169.70	169.34	169.50	100.53	99.84
149.55	197.47	193.65	170.19	169.68	169.32	169.49	100.52	99.80
150.05	197.50	193.65	170.19	169.69	169.33	169.51	100.51	99.83
150.55	197.47	193.67	170.18	169.69	169.31	169.51	100.50	99.70
151.05	197.51	193.69	170.18	169.67	169.26	169.49	100.52	99.86
151.55	197.49	193.68	170.18	169.69	169.33	169.50	100.51	99.81
152.05	197.46	193.70	170.09	169.57	169.12	169.28	100.33	99.54
152.55	197.46	193.72	170.07	169.61	169.23	169.43	100.21	99.74
153.05	197.48	193.70	170.09	169.63	169.27	169.47	100.28	99.95
153.55	197.50	193.72	170.15	169.65	169.31	169.50	100.42	100.01
154.04	197.54	193.72	170.15	169.67	169.31	169.51	100.45	99.97

154.55	197.52	193.74	170.19	169.69	169.33	169.53	100.51	100.02
155.05	197.51	193.74	170.17	169.69	169.33	169.55	100.49	99.95
155.55	197.47	193.76	170.18	169.69	169.33	169.53	100.49	99.83
156.05	197.49	193.75	170.18	169.66	169.32	169.51	100.48	99.79
156.55	197.48	193.75	170.16	169.68	169.32	169.50	100.46	99.93
157.05	197.51	193.73	170.17	169.68	169.30	169.50	100.45	99.99
157.55	197.48	193.79	170.17	169.67	169.31	169.48	100.46	99.98
158.05	197.48	193.79	170.15	169.67	169.31	169.49	100.44	99.87
158.55	197.50	193.80	170.14	169.65	169.31	169.49	100.42	99.80
159.05	197.49	193.82	170.16	169.67	169.29	169.49	100.46	99.85
159.55	197.49	193.82	170.14	169.66	169.30	169.49	100.42	99.67
160.05	197.55	193.79	170.13	169.66	169.30	169.48	100.39	99.80
160.55	197.49	193.84	170.15	169.70	169.28	169.50	100.46	99.78
161.05	197.46	193.84	170.15	169.66	169.30	169.50	100.44	99.80
161.55	197.45	193.83	170.13	169.65	169.31	169.50	100.43	99.79
162.05	197.47	193.85	170.17	169.67	169.31	169.52	100.45	99.89
162.55	197.45	193.83	170.14	169.67	169.31	169.51	100.45	99.84
163.05	197.42	193.83	170.16	169.69	169.31	169.51	100.50	99.88
163.55	197.38	193.84	170.16	169.67	169.31	169.51	100.50	99.90
164.05	197.37	193.84	170.13	169.69	169.33	169.53	100.55	99.78
164.55	197.30	193.84	170.15	169.61	169.16	169.19	100.47	98.87
165.05	197.30	193.84	170.04	169.57	169.21	169.41	100.21	99.83
165.55	197.36	193.85	170.08	169.61	169.25	169.45	100.26	99.97
166.05	197.41	193.87	170.14	169.60	169.27	169.49	100.37	99.97
166.55	197.41	193.87	170.12	169.67	169.31	169.53	100.42	99.95
167.05	197.42	193.87	170.14	169.69	169.31	169.55	100.49	100.03
167.55	197.47	193.87	170.18	169.69	169.31	169.53	100.52	100.04
168.05	197.48	193.93	170.16	169.68	169.33	169.53	100.52	99.92
168.55	197.44	193.93	170.17	169.68	169.32	169.54	100.55	100.00
169.05	197.39	193.95	170.17	169.68	169.32	169.54	100.54	100.02
169.55	197.43	193.95	170.15	169.74	169.33	169.52	100.55	99.86
170.05	197.41	193.96	170.17	169.69	169.33	169.52	100.56	99.86
170.55	197.38	193.96	170.18	169.71	169.33	169.51	100.55	99.92
171.05	197.37	193.98	170.16	169.67	169.35	169.49	100.56	99.95
171.55	197.37	193.98	170.07	169.55	169.12	169.28	100.33	99.47
172.05	197.31	193.98	170.07	169.59	169.25	169.45	100.25	99.86
172.55	197.39	193.99	170.08	169.57	169.18	169.28	100.33	99.48
173.05	197.43	194.01	170.06	169.58	169.23	169.47	100.23	99.81
173.55	197.47	194.03	170.10	169.61	169.27	169.51	100.39	99.99

174.05	197.45	194.05	170.16	169.67	169.33	169.53	100.50	100.15
174.55	197.45	194.03	170.16	169.67	169.33	169.53	100.56	100.20
175.05	197.46	194.05	170.16	169.68	169.33	169.53	100.56	100.01
175.55	197.44	194.04	170.16	169.68	169.32	169.52	100.53	99.98
176.05	197.44	194.04	170.15	169.68	169.32	169.52	100.51	99.95
176.55	197.45	194.06	170.13	169.65	169.30	169.48	100.47	99.91
177.05	197.47	194.08	170.10	169.63	169.29	169.47	100.45	99.95
177.55	197.45	194.08	170.12	169.63	169.29	169.47	100.44	99.93
178.05	197.36	194.09	170.14	169.64	169.28	169.47	100.48	99.91
178.55	197.40	194.09	170.12	169.64	169.30	169.46	100.44	99.82
179.05	197.39	194.07	170.13	169.64	169.28	169.48	100.46	100.01
179.55	197.34	194.08	170.13	169.64	169.27	169.48	100.45	99.95
180.05	197.35	194.10	170.13	169.65	169.29	169.48	100.47	99.89

Table B3 – Temperature and pressure data for run 5.

Time, min	T_1, °C	T_2, °C	T_3, °C	T_4, °C	T_5, °C	T_6, °C	P_{inj}, psi	P_{out}, psi
0.05	179.00	138.89	48.37	46.00	49.06	51.44	98.47	100.83
0.55	192.81	163.33	48.47	46.08	49.14	51.50	98.64	100.77
1.05	199.03	168.45	48.49	46.10	49.14	51.49	98.70	100.97
1.55	199.95	169.12	48.52	46.11	49.16	51.47	98.63	100.98
2.05	196.39	169.48	48.52	46.15	49.19	51.49	98.94	100.94
2.55	190.89	169.54	48.52	46.17	49.21	51.50	99.07	100.90
3.05	186.81	169.62	48.56	46.16	49.23	51.50	99.15	100.90
3.55	185.97	169.57	48.55	46.18	49.25	51.50	99.00	100.86
4.05	187.69	169.69	48.55	46.18	49.30	51.49	99.32	100.95
4.55	191.89	169.79	48.54	46.21	49.32	51.49	99.55	100.94
5.05	198.13	169.90	48.52	46.19	49.36	51.50	99.84	100.98
5.55	204.31	170.03	48.51	46.21	49.40	51.54	100.04	101.03
6.05	208.71	170.12	48.53	46.20	49.44	51.58	100.12	101.10
6.55	209.72	170.22	48.51	46.24	49.49	51.62	100.20	101.10
7.05	208.33	170.20	48.50	46.24	49.53	51.66	100.18	101.10
7.54	205.38	170.26	48.50	46.25	49.55	51.72	100.30	101.14
8.05	201.21	170.50	48.52	46.23	49.55	51.77	100.96	101.23
8.55	198.74	170.63	48.49	46.24	49.60	51.83	101.39	101.29
9.05	198.48	170.88	48.46	46.24	49.60	51.87	101.96	101.32
9.55	200.83	171.23	48.48	46.28	49.60	51.93	102.38	101.53
10.04	202.71	171.32	48.54	46.27	49.63	51.99	102.51	101.77
10.55	203.74	171.49	48.62	46.35	49.65	52.03	102.89	101.73
11.05	205.13	171.76	48.76	46.41	49.69	52.09	103.30	101.84
11.55	204.83	171.87	48.97	46.41	49.73	52.10	103.58	102.02
12.05	204.03	172.11	49.14	46.42	49.77	52.10	104.01	101.87
12.55	202.66	172.29	49.43	46.42	49.82	52.06	104.62	101.93
13.05	200.80	172.58	49.78	46.38	49.88	52.03	105.33	102.11
13.55	201.84	173.16	50.20	46.37	49.96	52.05	105.86	102.17
14.05	202.56	173.52	50.76	46.39	49.98	52.07	106.28	102.27
14.55	202.02	173.67	51.49	46.41	49.96	52.10	106.30	102.20
15.05	202.85	174.30	53.22	46.42	49.93	52.16	106.68	102.30
15.55	203.05	174.86	63.68	46.34	49.95	52.18	106.93	102.32
16.05	203.29	175.73	94.52	46.23	50.01	52.28	107.63	102.29
16.55	204.26	176.58	140.49	46.16	50.09	52.32	108.43	102.28
17.05	205.75	177.86	164.53	46.07	50.13	52.36	108.82	102.28
17.55	205.52	178.40	169.84	46.00	50.18	52.35	109.08	102.35

18.05	202.71	178.17	171.14	46.00	50.22	52.33	109.23	102.38
18.55	200.48	178.28	171.57	46.10	50.26	52.28	109.35	102.43
19.05	200.75	178.87	172.07	46.20	50.28	52.28	109.81	102.26
19.55	201.27	179.62	172.45	46.35	50.32	52.29	110.53	103.83
20.05	200.24	179.46	172.50	46.53	50.29	52.27	110.37	103.97
20.55	198.50	179.78	172.63	46.67	50.24	52.20	110.66	103.85
21.05	199.33	180.96	172.78	46.82	50.18	52.03	111.20	103.92
21.55	202.02	182.82	172.98	46.94	50.05	51.92	111.53	103.93
22.05	204.94	184.14	173.24	47.04	49.94	51.85	111.97	103.85
22.55	205.00	184.55	173.47	47.12	49.83	51.77	112.60	103.73
23.05	202.98	184.82	173.75	47.22	49.76	51.74	113.39	103.69
23.55	203.91	186.10	173.95	47.35	49.63	51.68	113.97	103.75
24.05	204.65	187.27	174.04	48.45	49.46	51.57	114.26	103.70
24.55	206.10	188.62	174.10	56.33	49.23	51.46	114.13	103.77
25.05	206.39	189.62	174.06	74.47	48.97	51.33	114.09	103.79
25.55	205.19	189.57	174.08	95.75	48.84	51.26	114.03	103.73
26.05	203.14	189.08	174.18	127.60	48.71	51.49	114.26	103.59
26.55	199.65	188.13	174.29	164.68	48.60	51.91	114.61	103.53
27.05	199.03	188.69	174.45	171.20	48.47	52.09	115.12	103.44
27.55	201.77	190.81	174.73	172.10	48.26	52.19	115.86	103.52
28.05	203.85	191.92	174.71	172.43	48.09	52.15	115.66	103.75
28.55	204.05	192.57	174.66	172.72	47.93	52.04	115.56	103.83
29.05	204.64	193.65	174.77	173.15	47.74	51.87	115.86	103.69
29.55	206.03	194.80	174.99	173.54	47.61	51.73	116.51	103.58
30.05	208.11	196.47	175.18	173.85	47.46	51.63	117.00	103.55
30.55	208.86	197.49	175.31	174.08	47.35	51.54	117.35	103.47
31.05	207.77	197.16	175.25	174.10	47.18	51.47	117.12	103.61
31.55	204.48	195.78	175.19	174.09	47.01	51.40	117.04	103.55
32.05	200.49	194.28	175.21	174.16	46.88	51.34	117.00	103.54
32.55	199.46	193.80	175.16	174.15	46.75	51.24	116.87	103.57
33.05	199.14	193.91	175.23	174.24	46.66	51.07	117.01	103.51
33.55	198.48	193.72	175.27	174.35	46.61	50.94	117.16	103.29
34.05	198.39	193.84	175.37	174.45	46.74	50.79	117.56	101.70
34.55	200.01	194.30	175.46	174.60	47.78	50.66	117.89	102.39
35.05	202.05	195.36	175.70	174.83	51.02	50.58	118.56	102.61
35.55	204.72	197.10	175.70	174.83	57.55	50.51	118.52	102.87
36.05	203.65	196.83	175.61	174.78	70.37	50.44	118.14	103.08
36.55	198.64	195.08	175.52	174.73	88.89	50.29	117.90	103.14
37.05	199.24	195.47	175.62	174.83	118.34	50.14	118.39	103.19

37.55	200.64	195.80	175.78	175.01	148.98	49.99	118.77	103.12
38.05	201.52	196.00	175.98	175.23	163.62	49.88	119.25	103.04
38.55	202.40	196.40	176.17	175.43	170.57	49.79	120.16	103.06
39.05	202.26	197.15	176.31	175.59	173.20	49.70	120.58	103.04
39.55	201.53	196.62	176.44	175.74	174.29	49.64	120.88	103.07
40.05	201.90	196.82	176.57	175.82	174.77	49.55	121.20	101.27
40.55	202.45	197.07	176.57	175.82	174.97	49.40	121.17	102.35
41.05	203.22	197.83	176.63	175.88	174.80	49.67	121.46	102.65
41.55	203.47	198.06	176.60	175.86	174.89	49.58	121.20	102.94
42.05	203.69	198.34	176.64	175.88	175.00	49.51	121.44	103.16
42.55	204.52	199.47	176.61	175.87	175.06	49.43	121.17	103.26
43.05	201.74	199.02	176.44	175.76	174.97	49.28	120.77	103.40
43.54	202.03	198.70	176.43	175.69	174.90	49.14	120.74	103.62
44.05	201.66	198.31	176.20	175.41	174.62	48.93	119.97	103.95
44.55	201.59	198.28	175.90	175.05	174.17	48.78	118.99	101.70
45.05	201.77	197.94	175.13	174.18	173.13	49.43	116.63	101.65
45.55	202.71	197.73	174.18	173.19	172.22	55.79	113.71	103.43
46.05	203.27	197.75	173.35	172.40	171.57	62.94	111.19	104.16
46.55	205.38	199.67	172.74	171.88	171.11	72.92	109.38	102.61
47.05	204.83	200.60	172.19	171.26	170.41	96.58	107.75	99.99
47.55	204.46	201.47	171.51	170.59	169.87	138.02	105.98	100.31
48.05	206.21	202.76	171.19	170.36	169.75	155.56	104.92	100.53
48.55	204.84	202.46	170.91	170.15	169.59	163.90	104.12	100.56
49.05	202.93	201.78	170.82	170.06	169.50	166.77	103.79	100.51
49.55	203.15	201.71	170.75	170.01	169.45	167.82	103.65	100.35
50.05	203.33	201.68	170.66	169.93	169.35	168.29	103.49	100.23
50.55	204.21	201.84	170.56	169.78	169.21	168.42	103.17	99.94
51.05	206.32	203.31	170.51	169.82	169.25	168.67	103.11	100.18
51.55	207.76	204.57	170.60	169.84	169.30	168.82	103.59	100.34
52.05	210.54	206.99	170.55	169.79	169.27	168.88	103.19	100.26
52.55	212.44	208.57	170.41	169.71	169.22	168.86	102.62	100.21
53.05	208.36	206.87	170.38	169.67	169.19	168.90	102.61	100.19
53.55	207.88	207.13	170.29	169.62	169.16	168.89	102.27	100.14
54.05	208.11	207.29	170.28	169.59	169.12	168.93	102.28	100.12
54.55	206.95	207.08	170.42	169.70	169.22	169.00	103.03	100.20
55.05	208.05	207.65	170.41	169.70	169.20	169.02	102.62	100.16
55.55	204.63	206.19	170.41	169.72	169.20	169.02	102.67	100.19
56.05	203.65	205.57	170.46	169.76	169.26	169.04	102.90	100.14
56.55	204.96	205.78	170.45	169.75	169.23	169.08	102.85	100.28

57.05	206.45	206.39	170.47	169.77	169.21	168.92	102.91	99.52
57.55	207.83	207.10	170.38	169.70	169.14	169.02	102.63	100.18
58.05	210.34	209.03	170.53	169.77	169.29	169.15	102.93	100.37
58.55	212.43	210.70	170.52	169.78	169.27	169.13	102.97	100.25
59.04	212.63	211.31	170.45	169.71	169.22	169.10	102.71	100.17
59.55	208.59	209.33	170.38	169.66	169.17	169.08	102.58	100.16
60.05	205.02	207.81	170.31	169.59	169.16	169.07	102.30	100.15
60.55	203.44	206.52	170.37	169.68	169.22	169.11	102.60	100.13
61.05	206.08	207.92	170.35	169.67	169.20	169.11	102.41	100.08
61.55	209.38	209.95	170.37	169.67	169.20	169.13	102.78	100.09
62.05	212.78	212.24	170.41	169.73	169.24	169.15	102.58	100.10
62.55	214.50	213.59	170.34	169.62	169.19	169.12	102.33	100.27
63.05	214.06	213.72	170.26	169.57	169.12	169.11	102.14	100.20
63.55	211.28	212.88	170.24	169.58	169.13	169.13	102.16	99.95
64.04	211.50	213.08	170.17	169.49	169.06	169.06	101.77	100.02
64.55	209.00	211.43	170.21	169.62	169.17	169.18	102.10	100.27
65.05	205.64	209.97	170.27	169.62	169.19	169.19	102.13	100.22
65.55	205.91	209.86	170.31	169.64	169.19	169.17	102.23	100.12
66.05	204.48	208.85	170.33	169.64	169.19	169.18	102.28	100.12
66.55	203.55	208.33	170.31	169.65	169.18	169.18	102.25	100.18
67.05	205.07	209.05	170.31	169.65	169.20	169.18	102.33	100.09
67.55	206.99	210.07	170.39	169.69	169.22	169.20	102.54	100.10
68.05	209.12	211.47	170.46	169.74	169.28	169.22	102.96	100.12
68.55	212.10	213.21	170.48	169.76	169.31	169.24	102.86	100.18
69.05	213.69	214.55	170.32	169.64	169.23	169.19	102.42	100.11
69.55	212.39	213.98	170.29	169.61	169.18	169.18	102.27	100.05
70.05	209.30	212.73	170.26	169.59	169.16	169.20	102.10	100.08
70.55	205.40	210.75	170.30	169.61	169.20	169.20	102.18	100.07
71.05	205.38	210.68	170.32	169.63	169.22	169.24	102.34	100.15
71.55	208.39	212.17	170.37	169.71	169.26	169.26	102.39	100.14
72.05	208.95	212.31	170.34	169.68	169.23	169.23	102.38	100.06
72.55	208.36	212.51	170.29	169.64	169.23	169.23	102.16	100.07
73.05	207.06	211.55	170.31	169.57	169.05	168.91	102.33	99.18
73.55	205.83	211.05	170.28	169.61	169.20	169.25	102.12	100.25
74.05	205.36	210.61	170.39	169.71	169.27	169.27	102.71	100.19
74.54	206.67	211.56	170.37	169.69	169.28	169.28	102.35	100.28
75.05	205.06	210.54	170.32	169.67	169.24	169.26	102.30	100.17
75.55	203.26	209.90	170.31	169.64	169.23	169.24	102.32	100.07
76.05	204.51	210.44	170.34	169.70	169.25	169.26	102.44	100.08

76.55	207.42	212.09	170.38	169.72	169.28	169.28	102.38	100.26
77.05	207.40	211.84	170.39	169.70	169.27	169.29	102.39	100.10
77.55	206.51	212.13	170.33	169.69	169.25	169.29	102.27	100.10
78.05	207.24	212.20	170.37	169.72	169.29	169.29	102.52	100.16
78.55	206.59	211.95	170.41	169.74	169.30	169.30	102.57	100.16
79.05	207.70	212.80	170.43	169.75	169.32	169.33	102.59	100.19
79.54	211.30	214.98	170.45	169.75	169.32	169.32	102.56	100.31
80.05	211.98	215.34	170.35	169.65	169.11	169.03	102.40	99.31
80.55	209.42	214.49	170.22	169.59	169.20	169.27	102.08	100.05
81.05	209.46	214.90	170.23	169.56	169.09	169.11	101.99	99.57
81.55	208.68	214.47	170.32	169.69	169.24	169.31	102.29	100.29
82.05	209.88	215.34	170.34	169.69	169.24	169.31	102.30	100.24
82.55	211.81	216.36	170.38	169.69	169.28	169.32	102.51	100.22
83.05	210.96	215.75	170.34	169.70	169.25	169.32	102.52	100.22
83.55	207.20	214.31	170.33	169.68	169.27	169.34	102.25	100.12
84.05	205.99	213.34	170.31	169.67	169.22	169.27	102.31	100.17
84.55	206.94	214.13	170.28	169.65	169.24	169.33	102.21	100.28
85.05	205.78	213.49	170.34	169.71	169.27	169.33	102.38	100.19
85.55	206.62	213.71	170.39	169.76	169.30	169.37	102.50	100.24
86.05	207.97	214.57	170.38	169.67	169.21	169.26	102.42	99.96
86.55	209.65	215.70	170.29	169.66	169.23	169.34	102.24	100.23
87.05	208.97	215.34	170.36	169.72	169.27	169.34	102.52	100.19
87.55	209.46	215.77	170.38	169.72	169.27	169.36	102.56	100.15
88.05	211.53	217.17	170.39	169.72	169.29	169.36	102.47	100.17
88.55	212.09	217.66	170.33	169.69	169.27	169.34	102.27	100.24
89.05	210.09	216.60	170.32	169.69	169.26	169.35	102.34	100.12
89.55	208.21	215.96	170.30	169.65	169.22	169.35	102.25	100.11
90.05	206.80	215.19	170.29	169.66	169.24	169.33	102.25	100.07
90.55	206.52	214.91	170.33	169.70	169.26	169.37	102.34	100.14
91.05	206.66	214.95	170.40	169.77	169.32	169.41	102.43	100.30
91.55	206.99	215.29	170.30	169.70	169.29	169.41	102.26	100.09
92.05	203.39	213.31	170.37	169.76	169.34	169.47	102.41	100.27
92.55	203.36	213.26	170.41	169.79	169.38	169.49	102.45	100.26
93.05	203.77	212.79	170.45	169.85	169.40	169.53	102.73	100.21
93.55	203.10	212.64	170.50	169.89	169.42	169.51	102.87	100.20
94.05	206.55	214.48	170.54	169.89	169.44	169.52	102.87	100.19
94.55	209.79	216.31	170.33	169.70	169.27	169.41	102.29	99.97
95.05	209.05	216.56	170.38	169.79	169.32	169.39	102.48	99.86
95.55	210.96	217.92	170.31	169.70	169.29	169.43	102.15	100.00

96.05	208.33	216.28	170.42	169.81	169.38	169.51	102.60	100.30
96.55	209.10	216.94	170.50	169.87	169.43	169.51	103.06	100.32
97.05	210.52	218.02	170.43	169.83	169.42	169.54	102.57	100.36
97.54	207.95	216.68	170.43	169.82	169.39	169.48	102.57	100.38
98.05	206.64	216.22	170.38	169.78	169.32	169.44	102.44	99.96
98.55	205.48	215.47	170.38	169.77	169.32	169.43	102.41	99.95
99.05	204.77	214.99	170.36	169.77	169.30	169.45	102.53	99.99
99.55	204.93	215.02	170.40	169.76	169.25	169.27	102.52	99.37
100.05	205.83	215.29	170.37	169.76	169.34	169.52	102.43	100.25
100.55	206.42	215.73	170.46	169.85	169.42	169.54	102.72	100.31
101.05	208.23	216.71	170.54	169.91	169.47	169.60	102.75	100.38
101.55	208.04	216.54	170.47	169.84	169.40	169.53	102.66	100.20
102.05	205.96	215.95	170.40	169.80	169.37	169.48	102.47	99.99
102.55	203.67	214.54	170.44	169.82	169.32	169.41	102.63	99.84
103.05	203.94	214.25	170.47	169.83	169.34	169.47	102.70	100.08
103.55	208.44	217.17	170.33	169.74	169.29	169.43	102.26	99.98
104.05	210.27	217.46	170.42	169.81	169.36	169.49	102.66	100.13
104.55	209.10	217.66	170.37	169.76	169.33	169.47	102.34	100.03
105.05	208.43	217.43	170.35	169.76	169.33	169.47	102.42	100.01
105.55	207.10	217.14	170.36	169.73	169.33	169.46	102.31	100.04
106.05	207.89	217.24	170.48	169.85	169.40	169.51	102.65	100.14
106.55	206.97	216.43	170.40	169.79	169.35	169.50	102.57	100.07
107.05	204.53	215.68	170.33	169.77	169.34	169.48	102.39	99.99
107.55	204.43	215.43	170.35	169.75	169.34	169.47	102.38	99.99
108.05	203.43	214.77	170.35	169.79	169.32	169.47	102.40	100.00
108.55	204.68	215.15	170.42	169.81	169.34	169.47	102.58	99.92
109.05	206.76	216.26	170.41	169.80	169.35	169.47	102.81	99.90
109.55	209.14	217.54	170.48	169.85	169.42	169.47	102.61	99.90
110.05	208.52	217.34	170.30	169.75	169.33	169.49	102.24	100.10
110.54	207.06	216.99	170.40	169.82	169.37	169.53	102.50	100.20
111.05	207.29	217.38	170.36	169.79	169.34	169.48	102.33	100.14
111.55	204.66	215.79	170.37	169.77	169.34	169.45	102.39	99.87
112.05	203.77	215.33	170.35	169.76	169.29	169.41	102.33	99.83
112.55	206.29	216.38	170.39	169.77	169.34	169.47	102.39	99.87
113.04	207.33	217.10	170.37	169.77	169.34	169.49	102.37	99.90
113.55	206.67	217.25	170.37	169.77	169.36	169.47	102.27	99.85
114.05	207.30	217.18	170.43	169.81	169.38	169.49	102.51	100.06
114.55	207.51	217.61	170.41	169.82	169.37	169.49	102.44	99.92
115.05	207.95	218.22	170.37	169.80	169.37	169.49	102.38	99.87

115.55	208.90	219.01	170.34	169.75	169.33	169.48	102.25	99.83
116.05	207.41	218.24	170.38	169.80	169.35	169.48	102.37	99.90
116.55	208.20	218.38	170.47	169.86	169.41	169.52	102.56	99.83
117.05	209.81	219.46	170.42	169.82	169.37	169.52	102.55	99.84
117.55	210.28	220.29	170.37	169.77	169.36	169.48	102.25	99.75
118.05	209.30	219.52	170.40	169.79	169.36	169.50	102.44	99.80
118.55	209.01	219.93	170.33	169.76	169.36	169.51	102.21	99.86
119.05	207.35	219.02	170.35	169.78	169.35	169.38	102.26	99.49
119.55	206.53	218.05	170.37	169.81	169.40	169.56	102.36	100.14
120.05	207.37	218.97	170.36	169.78	169.35	169.44	102.30	99.76
120.55	206.12	218.02	170.29	169.71	169.26	169.42	102.17	99.66
121.05	203.96	216.79	170.31	169.75	169.30	169.46	102.12	99.80
121.55	204.44	216.68	170.36	169.78	169.35	169.46	102.39	99.74
122.05	205.53	217.45	170.34	169.79	169.35	169.48	102.33	99.76
122.55	207.02	218.24	170.42	169.77	169.37	169.50	102.34	99.73
123.05	206.18	217.76	170.36	169.79	169.34	169.48	102.28	99.76
123.55	204.52	217.20	170.36	169.79	169.38	169.48	102.28	99.70
124.05	205.70	217.37	170.44	169.83	169.39	169.50	102.93	99.84
124.55	208.42	219.44	170.37	169.77	169.36	169.45	102.20	99.76
125.05	204.39	218.26	170.31	169.72	169.29	169.43	102.13	99.62
125.55	204.22	217.19	170.39	169.77	169.36	169.50	102.53	99.85
126.05	207.65	219.43	170.35	169.79	169.38	169.52	102.19	99.93
126.55	206.62	218.73	170.42	169.83	169.38	169.51	102.44	99.86
127.05	207.10	219.24	170.39	169.78	169.35	169.47	102.34	99.81
127.55	207.78	219.76	170.36	169.76	169.33	169.46	102.16	99.66
128.05	206.84	219.31	170.29	169.71	169.30	169.46	102.09	99.87
128.55	203.24	217.05	170.34	169.75	169.30	169.44	102.18	99.86
129.05	203.74	216.88	170.45	169.80	169.37	169.46	102.41	99.64
129.55	208.77	219.87	170.34	169.77	169.35	169.50	102.05	99.70
130.05	207.81	218.92	170.36	169.78	169.37	169.50	102.21	99.98
130.55	207.22	219.31	170.34	169.77	169.34	169.50	102.20	99.68
131.05	206.44	218.81	170.38	169.78	169.35	169.50	102.25	99.84
131.55	207.36	219.06	170.41	169.82	169.37	169.50	102.39	99.72
132.05	207.16	218.90	170.40	169.82	169.37	169.50	102.33	99.72
132.55	205.68	218.53	170.45	169.86	169.37	169.52	102.46	99.71
133.05	207.72	219.69	170.41	169.84	169.37	169.52	102.35	99.70
133.55	211.35	221.69	170.38	169.80	169.37	169.50	102.25	99.65
134.05	209.60	220.75	170.36	169.79	169.37	169.50	102.22	99.62
134.55	208.11	220.52	170.40	169.80	169.37	169.52	102.29	99.65

135.05	210.08	221.75	170.38	169.81	169.37	169.50	102.22	99.70
135.55	207.65	220.75	170.42	169.81	169.37	169.50	102.36	99.63
136.05	206.97	220.59	170.37	169.77	169.27	169.30	102.26	98.88
136.55	208.85	221.40	170.28	169.72	169.30	169.48	101.94	99.80
137.05	209.55	221.84	170.33	169.72	169.34	169.50	102.17	99.65
137.55	208.94	221.81	170.35	169.76	169.32	169.45	102.13	99.78
138.05	210.34	222.38	170.39	169.77	169.34	169.47	102.14	99.54
138.55	210.55	222.17	170.33	169.76	169.32	169.47	102.26	99.69
139.05	209.32	222.31	170.30	169.74	169.32	169.49	101.99	99.76
139.55	207.49	220.38	170.44	169.81	169.40	169.52	102.66	99.91
140.05	207.90	220.84	170.37	169.79	169.38	169.50	102.24	99.81
140.55	206.67	220.39	170.33	169.77	169.32	169.50	101.99	99.59
141.05	202.68	218.75	170.39	169.83	169.36	169.50	102.27	99.68
141.55	203.25	218.30	170.44	169.85	169.38	169.52	102.47	99.83
142.05	206.77	220.20	170.46	169.85	169.40	169.52	102.52	99.66
142.55	210.62	222.11	170.28	169.68	169.23	169.36	102.03	99.25
143.05	207.35	220.84	170.39	169.81	169.36	169.50	102.49	99.78
143.55	210.46	222.67	170.35	169.76	169.34	169.49	102.18	99.70
144.05	209.51	221.97	170.37	169.78	169.36	169.43	102.27	99.68
144.55	209.91	222.65	170.31	169.72	169.31	169.47	102.04	99.68
145.05	209.60	222.74	170.30	169.72	169.29	169.43	102.02	99.67
145.55	209.07	222.63	170.32	169.72	169.31	169.47	102.02	99.77
146.05	208.69	222.20	170.33	169.74	169.31	169.43	102.07	99.68
146.55	208.05	221.92	170.32	169.70	169.29	169.42	102.12	99.53
147.05	210.70	223.33	170.32	169.72	169.33	169.49	101.90	99.82
147.55	208.01	222.10	170.35	169.79	169.33	169.49	102.26	99.78
148.05	206.96	222.15	170.35	169.78	169.33	169.51	102.12	99.71
148.55	207.76	222.20	170.35	169.78	169.36	169.49	102.22	99.73
149.04	205.61	220.91	170.39	169.79	169.34	169.49	102.27	99.75
149.55	207.69	221.95	170.41	169.81	169.38	169.50	102.41	99.83
150.05	210.75	223.47	170.44	169.83	169.41	169.52	102.30	99.80
150.55	209.73	222.72	170.39	169.83	169.38	169.50	102.34	99.71
151.05	210.07	223.62	170.33	169.76	169.34	169.50	102.14	99.70
151.55	209.19	223.08	170.35	169.76	169.29	169.36	102.16	99.23
152.05	210.16	223.46	170.28	169.68	169.29	169.40	101.89	99.49
152.55	211.79	224.76	170.24	169.68	169.29	169.49	101.88	99.91
153.05	208.64	222.99	170.32	169.74	169.31	169.47	102.00	99.79
153.55	207.72	222.47	170.30	169.72	169.29	169.47	102.02	99.72
154.04	206.36	221.65	170.31	169.72	169.31	169.49	102.01	99.75

154.55	206.29	221.50	170.33	169.76	169.34	169.47	102.11	99.81
155.05	206.54	221.41	170.30	169.72	169.27	169.43	102.08	99.58
155.55	205.81	221.25	170.31	169.76	169.31	169.47	102.24	99.74
156.05	208.85	222.54	170.35	169.77	169.34	169.50	102.17	99.75
156.55	210.03	223.27	170.29	169.74	169.34	169.48	102.05	99.83
157.05	209.60	223.20	170.37	169.77	169.36	169.52	102.32	99.74
157.55	212.05	224.55	170.38	169.79	169.38	169.50	102.52	99.66
158.05	213.66	225.85	170.29	169.74	169.34	169.50	102.10	99.87
158.55	207.77	223.52	170.40	169.81	169.38	169.52	102.25	99.83
159.05	208.67	224.29	170.28	169.72	169.32	169.48	101.90	99.77
159.55	204.95	222.09	170.37	169.79	169.38	169.52	102.17	99.69
160.05	207.83	222.65	170.40	169.81	169.38	169.52	102.39	99.78
160.55	209.87	224.03	170.33	169.75	169.36	169.50	102.16	99.73
161.05	208.94	223.85	170.33	169.75	169.36	169.52	102.11	99.73
161.55	207.13	222.90	170.33	169.75	169.36	169.48	102.07	99.78
162.05	206.77	222.27	170.37	169.79	169.38	169.52	102.22	99.82
162.55	207.49	222.58	170.35	169.77	169.36	169.52	102.12	99.78
163.05	205.43	221.23	170.22	169.66	169.29	169.48	101.80	99.92
163.55	204.89	220.73	170.33	169.75	169.36	169.50	102.09	99.94
164.05	206.18	221.39	170.29	169.72	169.28	169.41	102.04	99.64
164.55	207.94	222.02	170.27	169.72	169.30	169.45	102.19	99.76
165.05	207.65	222.18	170.31	169.68	169.34	169.48	102.44	99.56
165.55	210.91	224.49	170.29	169.72	169.34	169.48	102.03	99.75
166.05	210.21	224.19	170.33	169.75	169.36	169.48	102.06	99.82
166.55	210.53	224.31	170.35	169.77	169.41	169.50	102.38	99.88
167.04	210.51	225.13	170.27	169.72	169.34	169.50	101.94	99.76
167.55	206.95	223.27	170.29	169.73	169.36	169.50	102.01	99.84
168.05	204.84	222.43	170.27	169.74	169.36	169.50	102.02	99.82
168.55	203.46	221.12	170.35	169.77	169.36	169.52	102.19	99.81
169.05	203.66	220.39	170.42	169.81	169.43	169.52	102.61	99.79
169.55	205.20	221.30	170.38	169.79	169.41	169.52	102.26	99.88
170.05	205.97	222.43	170.36	169.79	169.37	169.50	102.18	99.83
170.55	207.35	223.29	170.35	169.79	169.38	169.50	102.27	99.87
171.05	208.44	223.99	170.37	169.79	169.38	169.54	102.27	99.80
171.55	209.76	224.67	170.40	169.83	169.41	169.52	102.40	99.98
172.04	211.73	225.51	170.33	169.70	169.32	169.45	102.27	99.71
172.55	214.61	227.93	170.26	169.66	169.30	169.46	101.95	99.90
173.05	210.01	226.80	170.29	169.72	169.34	169.46	101.97	99.94
173.55	210.12	225.67	170.29	169.70	169.28	169.43	102.03	99.72

174.05	208.69	224.87	170.27	169.68	169.28	169.43	102.03	99.69
174.55	209.53	225.56	170.29	169.72	169.32	169.48	101.93	99.78
175.05	210.83	226.10	170.29	169.72	169.36	169.50	101.97	99.82
175.55	208.99	224.96	170.28	169.70	169.34	169.47	102.05	99.93
176.05	206.00	223.94	170.26	169.70	169.32	169.47	102.00	99.79
176.55	205.72	223.42	170.30	169.74	169.36	169.50	102.02	99.94
177.05	203.93	221.92	170.31	169.76	169.36	169.50	102.19	99.95
177.55	201.37	221.24	170.37	169.79	169.38	169.51	102.27	99.90
178.05	208.23	223.20	170.40	169.79	169.41	169.54	102.25	99.95
178.55	209.91	223.89	170.35	169.74	169.38	169.51	102.20	100.01
179.05	207.99	223.42	170.30	169.74	169.36	169.49	102.03	100.14
179.55	203.88	222.83	170.33	169.78	169.36	169.51	102.31	99.98
180.05	204.84	221.77	170.42	169.79	169.40	169.52	102.68	99.98

Table B4 – Temperature and pressure data for run 6.

Time, min	T_1, °C	T_2, °C	T_3, °C	T_4, °C	T_5, °C	T_6, °C	P_{inj}, psi	P_{out}, psi
0.05	160.13	85.87	49.53	47.79	44.14	57.97	119.32	102.06
0.55	194.01	171.58	49.65	47.80	44.19	58.06	98.29	100.95
1.05	173.15	169.90	49.59	47.73	44.10	58.01	97.74	100.50
1.55	173.23	170.39	49.65	47.78	44.11	58.02	97.61	100.17
2.05	174.72	172.92	49.64	47.79	44.14	58.01	98.19	100.22
2.54	174.58	173.57	49.65	47.76	44.19	58.04	98.22	100.42
3.05	175.13	175.33	49.68	47.79	44.20	58.03	98.40	100.48
3.55	175.10	176.18	49.69	47.82	44.23	58.02	98.55	100.31
4.05	175.02	176.70	49.70	47.81	44.24	58.03	99.03	100.46
4.55	174.87	176.26	49.71	47.80	44.25	58.02	99.09	100.42
5.05	174.54	175.58	49.72	47.79	44.24	58.02	99.32	100.42
5.55	173.94	174.87	49.71	47.79	44.23	58.01	99.21	100.61
6.05	173.35	174.45	49.80	47.76	44.28	57.98	99.81	100.56
6.55	173.15	173.99	49.71	47.73	44.23	58.02	100.14	100.59
7.05	173.05	174.34	49.68	47.74	44.22	58.05	100.56	100.56
7.55	173.11	174.48	49.56	47.73	44.19	58.10	100.87	100.67
8.05	173.50	174.68	49.59	47.76	44.18	58.11	101.32	100.78
8.55	174.13	175.46	49.50	47.80	44.19	58.10	102.32	100.78
9.05	174.95	175.51	49.55	47.79	44.20	58.09	102.41	100.90
9.55	175.41	176.47	49.48	47.78	44.19	58.04	102.54	101.10
10.04	175.38	176.41	49.49	47.73	44.20	57.97	102.74	101.00
10.55	175.28	177.02	49.48	47.72	44.26	57.91	103.31	101.17
11.05	175.52	176.89	49.55	47.73	44.31	57.92	103.49	101.19
11.55	175.84	176.70	49.84	47.72	44.30	57.92	104.25	101.25
12.05	178.81	177.21	50.44	47.75	44.23	57.95	104.88	101.27
12.55	179.54	177.07	57.60	47.72	44.22	57.98	105.15	101.44
13.05	182.07	177.35	100.22	47.82	44.27	58.08	105.67	101.46
13.55	184.09	178.40	137.92	47.83	44.31	58.18	106.44	101.48
14.05	184.76	178.19	156.42	47.80	44.32	58.06	106.40	102.41
14.55	184.41	177.91	165.32	47.88	44.37	58.05	106.72	101.54
15.05	183.86	177.52	168.75	47.97	44.38	58.02	107.06	102.46
15.55	181.52	178.43	170.61	47.96	44.38	57.97	108.55	101.47
16.05	186.30	179.14	171.73	48.02	44.39	58.05	109.34	101.49
16.55	187.59	179.81	172.17	48.10	44.32	57.96	109.61	101.63
17.05	197.82	180.73	172.46	48.21	44.29	57.86	110.07	103.40
17.55	201.60	181.55	172.69	48.27	44.30	57.65	110.24	103.43

18.05	203.06	181.95	172.96	48.28	44.17	57.40	110.91	103.29
18.55	203.14	182.53	173.13	48.27	44.25	57.29	111.20	103.25
19.05	202.71	183.04	173.27	48.29	44.30	57.22	111.23	103.20
19.55	201.86	183.24	173.32	48.34	44.36	57.11	111.33	103.13
20.05	200.61	183.16	173.51	48.61	44.37	56.97	111.70	102.95
20.54	198.22	182.88	173.81	51.57	44.32	56.77	112.46	102.81
21.05	196.70	183.35	174.03	66.86	44.31	56.56	113.10	102.73
21.55	177.95	182.87	174.23	93.86	44.33	56.38	113.58	102.80
22.05	177.96	183.77	174.24	122.67	44.40	56.27	113.74	102.83
22.55	185.63	185.99	174.35	139.92	44.46	56.16	114.01	102.86
23.05	192.36	187.77	174.50	153.36	44.52	56.04	114.28	102.69
23.55	187.74	188.15	174.63	167.31	44.57	55.84	114.83	102.62
24.05	190.56	189.91	174.78	171.55	44.63	55.44	115.33	102.58
24.55	194.36	190.49	174.91	172.68	44.70	54.80	115.60	102.53
25.05	187.00	191.00	175.13	173.48	44.76	54.14	116.17	102.58
25.55	192.47	193.46	175.27	173.97	44.80	53.48	116.69	102.49
26.05	198.91	194.61	175.49	174.35	44.83	52.82	117.08	102.39
26.55	201.62	194.90	175.64	174.59	44.83	52.22	117.42	102.40
27.05	203.50	195.21	175.82	174.83	44.88	51.61	117.89	102.29
27.55	196.67	194.23	175.92	174.95	44.86	50.93	118.15	102.30
28.05	181.65	192.70	175.87	174.90	44.81	50.16	118.05	102.30
28.55	181.10	192.90	175.86	174.89	44.80	49.44	118.28	102.36
29.05	187.17	195.23	175.95	175.00	44.96	48.78	118.44	102.45
29.55	196.85	197.98	175.92	175.02	45.86	48.14	118.19	102.32
30.05	201.71	199.27	175.91	175.06	47.89	47.72	118.03	102.32
30.55	204.15	199.87	175.93	175.09	51.10	47.34	118.25	102.19
31.05	205.85	200.07	175.86	175.14	56.28	46.91	117.89	101.75
31.55	183.70	198.39	175.74	174.90	63.85	46.55	117.52	102.05
32.05	185.42	199.85	175.80	174.95	71.17	46.27	117.70	102.10
32.55	196.52	202.11	175.66	174.82	81.02	45.93	117.34	102.14
33.05	206.73	203.54	175.54	174.73	103.50	45.59	116.85	102.20
33.55	209.24	203.94	175.45	174.66	139.58	45.29	116.47	102.13
34.05	192.18	201.91	175.46	174.68	166.71	45.10	116.47	101.95
34.55	189.46	199.83	175.41	174.56	172.42	44.95	116.20	101.79
35.05	184.89	198.55	175.39	174.66	173.31	44.81	116.17	101.65
35.55	180.77	198.55	175.42	174.66	173.64	44.69	116.35	101.60
36.05	184.97	199.54	175.44	174.70	173.95	44.57	116.46	101.27
36.55	187.70	200.50	175.46	174.72	173.57	44.30	116.47	101.81
37.05	194.95	203.22	175.48	174.75	173.70	43.98	116.38	101.83

37.55	205.10	206.46	175.47	174.73	173.74	43.89	116.39	101.82
38.05	211.82	208.24	175.36	174.63	173.67	43.89	116.11	101.94
38.55	212.38	208.51	175.26	174.54	173.64	43.92	115.98	101.84
39.05	211.06	207.91	175.14	174.44	173.56	43.96	115.22	101.84
39.55	192.14	205.12	175.02	174.30	173.38	43.94	114.75	101.87
40.05	182.54	202.99	174.82	174.08	173.20	43.93	114.30	101.91
40.55	182.46	202.76	174.75	173.98	173.06	44.01	114.23	101.98
41.05	194.38	204.83	174.63	173.88	172.99	44.34	113.66	102.09
41.55	206.22	206.44	174.35	173.59	172.73	45.07	112.83	101.90
42.05	209.59	207.02	174.06	173.31	172.46	46.75	111.89	102.23
42.55	209.04	206.39	173.80	173.04	172.12	51.24	111.17	102.28
43.05	195.90	203.96	173.44	172.63	171.71	60.55	110.01	102.48
43.54	193.77	203.03	173.08	172.24	171.32	79.10	108.93	101.27
44.05	177.18	202.93	172.73	171.83	170.91	126.18	108.11	101.30
44.55	190.61	204.94	172.46	171.58	170.70	154.54	107.47	101.24
45.05	203.45	207.68	171.90	171.01	170.07	161.51	105.54	100.08
45.55	210.90	209.13	171.44	170.63	169.82	164.47	104.24	100.33
46.05	211.84	209.29	171.15	170.33	169.64	166.58	103.34	100.20
46.55	209.26	207.72	171.00	170.24	169.49	167.54	102.85	99.99
47.05	194.83	206.20	170.86	170.12	169.36	168.03	102.53	99.87
47.55	194.16	206.62	170.91	170.16	169.40	168.43	102.91	99.97
48.05	207.50	208.93	170.90	170.16	169.42	168.67	102.68	99.90
48.55	211.92	210.29	170.83	170.11	169.41	168.78	102.51	99.95
49.05	212.07	209.88	170.80	170.04	169.36	168.89	102.30	99.92
49.55	207.22	208.24	170.71	170.01	169.32	168.93	102.00	99.90
50.05	188.85	206.81	170.73	170.03	169.29	169.00	102.14	99.97
50.55	190.61	207.14	170.88	170.14	169.40	169.10	102.56	100.02
51.05	200.00	207.68	170.79	170.03	169.30	169.03	102.34	99.86
51.55	208.31	210.31	170.86	170.13	169.43	169.23	102.50	100.21
52.05	213.35	212.55	170.85	170.15	169.43	169.25	102.48	100.11
52.55	214.58	212.63	170.91	170.11	169.41	169.25	102.46	100.21
53.05	208.67	210.80	170.78	170.04	169.34	169.23	102.20	100.12
53.55	189.84	209.62	170.77	170.05	169.33	169.22	102.28	99.94
54.05	193.64	210.54	170.88	170.14	169.42	169.29	102.66	100.11
54.55	208.75	212.63	171.17	170.11	169.42	168.97	102.53	100.16
55.05	214.48	213.67	170.81	170.09	169.41	169.30	102.40	100.05
55.55	213.27	212.78	170.78	170.08	169.36	169.34	102.19	99.98
56.05	201.71	211.96	170.74	170.01	169.32	169.29	102.19	100.02
56.55	208.19	211.88	170.78	170.06	169.36	169.34	102.29	100.10

57.05	212.18	213.51	170.82	170.10	169.40	169.36	102.36	100.13
57.55	215.24	215.44	170.80	170.08	169.40	169.38	102.24	100.05
58.05	216.91	215.77	170.72	170.01	169.35	169.35	102.11	100.00
58.55	213.12	214.39	170.68	169.96	169.28	169.12	101.95	99.01
59.05	210.56	213.41	170.69	169.98	169.34	169.37	101.99	100.11
59.55	212.66	214.29	170.83	170.13	169.45	169.39	102.58	100.16
60.05	215.42	215.87	170.76	170.06	169.38	169.05	102.07	100.04
60.55	214.95	215.13	170.75	170.03	169.36	169.04	102.08	100.01
61.05	211.38	213.71	170.71	170.01	169.31	169.02	101.99	100.01
61.55	179.40	212.33	170.77	170.02	169.31	169.01	102.27	99.95
62.05	195.72	213.32	170.88	170.16	169.44	169.08	102.50	100.07
62.55	212.85	215.22	170.81	170.09	169.43	169.05	102.35	100.00
63.05	216.49	216.09	170.70	170.02	169.36	169.05	102.08	99.89
63.55	211.23	214.09	170.73	170.02	169.34	169.05	101.97	99.92
64.05	189.51	212.84	170.76	170.06	169.36	169.05	102.30	99.98
64.55	211.54	214.63	170.86	170.14	169.45	169.11	102.49	99.98
65.05	215.57	216.10	170.82	170.14	169.45	169.13	102.37	99.99
65.55	216.73	216.55	170.81	170.11	169.33	168.83	102.15	98.94
66.05	214.66	214.75	170.72	170.07	169.42	169.15	101.85	100.00
66.55	195.67	213.28	170.70	170.04	169.37	169.10	101.95	99.92
67.05	180.12	212.30	170.81	170.08	169.39	169.10	102.31	100.23
67.55	186.01	212.21	170.89	170.15	169.43	169.11	102.61	100.04
68.05	209.98	216.03	170.91	170.15	169.47	169.13	102.47	99.89
68.55	218.66	218.66	170.82	170.10	169.42	169.13	102.29	99.86
69.05	220.60	218.91	170.79	170.07	169.40	169.11	102.16	99.87
69.55	217.48	217.84	170.68	170.01	169.44	169.10	101.99	99.84
70.05	208.50	215.96	170.72	170.02	169.35	169.10	101.88	99.94
70.55	180.46	214.43	170.76	170.04	169.35	169.10	102.17	99.95
71.05	194.88	214.75	170.85	170.11	169.39	168.92	102.41	99.11
71.55	206.25	215.69	170.78	170.08	169.38	169.14	102.36	99.99
72.05	216.53	217.78	170.87	170.10	169.36	168.98	102.48	99.44
72.55	218.80	218.91	170.77	170.05	169.40	169.11	102.12	99.95
73.05	219.18	219.36	170.77	170.05	169.38	169.11	102.06	99.95
73.55	221.73	221.05	170.81	170.09	169.42	169.13	102.50	100.03
74.05	223.27	222.19	170.76	170.07	169.41	169.14	102.18	100.01
74.55	220.94	220.94	170.70	170.02	169.37	169.14	101.83	100.20
75.05	218.08	219.60	170.69	169.99	169.34	169.12	101.89	100.03
75.55	218.32	219.34	170.75	170.04	169.36	169.14	102.23	100.02
76.05	220.59	220.56	170.78	170.08	169.42	169.17	102.19	100.11

76.55	223.03	222.22	170.77	170.08	169.42	169.18	102.16	100.11
77.05	223.33	222.15	170.72	169.98	169.40	169.17	101.86	100.01
77.55	219.15	220.42	170.68	170.00	169.33	169.15	101.85	100.04
78.05	180.69	218.29	170.74	170.04	169.30	169.14	102.28	100.04
78.55	196.96	217.81	170.90	170.18	169.48	169.21	102.69	100.16
79.05	216.94	220.14	170.85	170.15	169.48	169.20	102.52	100.05
79.55	220.79	220.36	170.82	170.13	169.43	169.22	102.37	99.98
80.05	220.16	219.72	170.75	170.07	169.40	169.18	102.07	100.00
80.55	220.26	219.52	170.78	170.07	169.31	168.88	102.26	98.95
81.05	177.40	218.00	170.72	170.05	169.33	169.17	102.22	100.11
81.55	210.13	219.67	170.86	170.16	169.44	169.23	102.47	100.18
82.05	222.02	222.39	170.79	170.09	169.41	169.21	102.34	100.03
82.55	223.74	222.81	170.76	170.06	169.39	169.18	102.14	100.00
83.05	222.88	222.25	170.65	169.99	169.32	169.16	101.77	99.98
83.55	218.64	221.61	170.69	170.01	169.34	169.16	102.10	100.02
84.05	223.51	223.22	170.67	170.01	169.36	169.20	101.93	100.04
84.55	223.51	222.67	170.64	169.99	169.35	169.20	101.79	100.01
85.05	222.01	221.90	170.59	169.94	169.31	169.19	101.62	99.98
85.55	209.99	220.85	170.63	169.96	169.33	169.17	101.79	99.98
86.05	215.43	220.67	170.76	170.07	169.41	169.23	102.27	100.09
86.55	222.34	222.57	170.78	170.11	169.43	169.21	102.29	100.08
87.05	224.44	223.43	170.69	170.04	169.43	169.21	101.98	99.99
87.55	222.40	221.79	170.69	170.06	169.40	169.25	101.83	100.11
88.05	195.82	219.93	170.66	170.03	169.36	169.20	101.87	99.99
88.55	190.28	218.61	170.71	170.07	169.36	169.22	102.02	100.26
89.05	189.55	218.84	170.73	170.08	169.38	169.22	102.15	100.07
89.55	192.26	219.22	170.70	170.05	169.37	169.26	102.07	100.18
90.05	208.81	220.26	170.70	169.98	169.23	169.05	102.07	99.80
90.55	219.94	222.64	170.67	170.06	169.39	169.25	101.84	100.30
91.05	224.76	224.24	170.62	169.99	169.36	169.21	101.75	100.27
91.55	224.19	223.38	170.64	170.01	169.36	169.22	101.87	100.01
92.05	214.11	222.36	170.60	169.99	169.42	169.24	101.67	99.98
92.55	199.40	221.13	170.62	169.99	169.33	169.20	101.80	100.04
93.05	203.43	220.62	170.73	170.07	169.38	169.24	102.09	100.05
93.55	217.40	221.23	170.79	170.12	169.46	169.26	102.24	100.01
94.05	223.18	223.29	170.72	170.09	169.44	169.26	101.90	99.95
94.55	224.63	223.25	170.63	169.98	169.32	169.21	101.73	99.94
95.05	222.20	222.04	170.62	169.97	169.39	169.27	101.55	99.97
95.55	197.98	220.61	170.60	169.95	169.29	169.09	101.71	99.70

96.05	188.74	219.41	170.73	170.03	169.36	169.24	101.90	100.04
96.55	190.86	219.41	170.75	170.12	169.40	169.26	102.18	100.09
97.05	217.23	220.74	170.84	170.17	169.51	169.33	102.29	100.11
97.54	223.55	222.62	170.74	170.11	169.44	169.28	101.99	100.04
98.05	225.26	223.30	170.67	170.07	169.42	169.24	101.78	99.92
98.55	207.83	221.21	170.72	170.11	169.45	169.30	101.88	100.05
99.05	177.04	219.05	170.71	170.10	169.39	169.27	102.02	99.96
99.55	181.54	217.55	170.78	170.15	169.43	169.27	102.19	100.01
100.05	210.86	218.25	170.82	170.17	169.51	169.33	102.24	99.96
100.55	190.14	218.70	170.79	170.14	169.45	169.29	102.15	99.97
101.05	215.91	219.61	170.82	170.19	169.49	169.33	102.23	100.01
101.55	214.85	220.40	170.81	170.16	169.46	169.33	102.10	100.11
102.05	216.25	220.78	170.76	170.13	169.44	169.32	102.03	100.02
102.55	203.44	221.03	170.74	170.20	169.39	169.28	101.99	100.01
103.05	222.50	223.02	170.81	170.17	169.50	169.36	102.14	100.08
103.55	225.78	224.44	170.76	170.15	169.50	169.40	102.12	100.03
104.05	226.95	225.01	170.73	170.14	169.51	169.38	101.93	99.95
104.55	225.36	223.53	170.77	170.16	169.53	169.42	101.90	99.97
105.05	205.12	221.74	170.73	170.10	169.39	169.35	101.85	99.93
105.55	187.46	221.03	170.68	170.05	169.39	169.32	101.71	100.11
106.05	189.72	221.23	170.74	170.13	169.41	169.37	101.95	100.28
106.55	206.79	221.77	170.81	170.18	169.53	169.41	102.19	100.23
107.05	220.91	222.84	170.83	170.19	169.56	169.43	102.16	100.25
107.55	224.78	223.76	170.76	170.15	169.50	169.40	102.00	99.99
108.05	210.71	223.51	170.77	170.12	169.47	169.36	102.05	100.01
108.55	221.49	223.19	170.84	170.19	169.53	169.42	102.21	100.06
109.05	221.99	223.32	170.91	170.19	169.55	169.42	102.17	100.02
109.55	217.54	222.78	170.72	170.09	169.37	169.24	101.88	99.74
110.05	190.81	222.01	170.81	170.16	169.48	169.39	102.28	100.20
110.55	219.78	222.45	170.94	170.31	169.62	169.50	102.56	100.31
111.05	225.60	224.11	170.92	170.31	169.65	169.47	102.44	100.15
111.55	226.84	224.26	170.85	170.29	169.59	169.41	102.41	99.98
112.05	210.19	222.27	170.82	170.24	169.54	169.40	102.10	99.96
112.55	177.13	220.38	170.80	170.19	169.49	169.44	102.20	99.96
113.05	174.29	218.57	170.82	170.19	169.45	169.29	102.36	99.83
113.55	184.93	218.09	170.86	170.23	169.56	169.40	102.42	100.10
114.05	216.43	219.67	170.95	170.32	169.66	169.48	102.49	100.15
114.55	221.82	220.64	170.83	170.25	169.60	169.42	102.29	100.04
115.05	223.02	220.57	170.90	170.25	169.61	169.44	102.34	99.95

115.55	223.63	220.73	170.90	170.29	169.66	169.52	102.35	100.05
116.05	223.99	220.96	170.90	170.31	169.68	169.43	102.23	99.87
116.55	180.50	220.07	170.98	170.33	169.67	169.49	102.60	99.97
117.05	187.47	219.02	170.98	170.33	169.65	169.47	102.59	100.01
117.55	176.21	219.02	170.95	170.33	169.62	169.45	102.61	99.95
118.05	177.06	219.00	170.97	170.30	169.62	169.37	102.61	99.98
118.55	185.05	218.81	170.99	170.32	169.60	169.42	102.71	99.91
119.05	183.10	219.63	170.99	170.32	169.58	169.42	102.80	100.02
119.55	194.07	221.50	171.04	170.34	169.62	169.43	102.89	99.91
120.05	225.22	223.83	170.94	170.33	169.70	169.43	102.76	99.95
120.55	220.30	224.49	170.92	170.26	169.55	169.39	102.51	99.87
121.05	227.39	225.51	170.92	170.26	169.57	169.43	102.49	99.92
121.55	218.91	225.50	170.95	170.28	169.58	169.41	102.55	100.08
122.05	220.81	226.52	170.93	170.26	169.54	169.42	102.45	100.03
122.55	227.04	226.95	170.89	170.23	169.53	169.40	102.43	99.94
123.05	210.74	226.77	170.93	170.23	169.51	169.37	102.66	99.92
123.55	230.25	229.15	170.88	170.23	169.55	169.40	102.49	99.90
124.05	233.33	230.45	170.79	170.16	169.51	169.39	102.27	100.02
124.55	230.86	228.51	170.78	170.16	169.50	169.37	102.12	99.99
125.05	210.91	226.64	170.78	170.11	169.37	169.36	102.13	100.01
125.55	213.23	225.83	170.89	170.22	169.52	169.38	102.47	99.92
126.05	228.50	227.32	170.87	170.28	169.58	169.45	102.29	99.98
126.55	231.57	228.38	170.71	170.10	169.43	169.34	101.91	99.94
127.05	232.36	228.88	170.68	170.08	169.51	169.40	101.84	99.92
127.55	226.99	226.86	170.82	170.21	169.58	169.47	102.04	99.96
128.05	185.00	225.32	170.73	170.14	169.56	169.42	101.98	99.90
128.55	182.90	223.21	170.74	170.21	169.55	169.44	102.16	99.97
129.05	182.15	221.67	170.86	170.23	169.55	169.42	102.38	100.05
129.55	187.58	220.60	170.86	170.25	169.57	169.44	102.39	99.98
130.05	218.96	221.41	170.90	170.31	169.62	169.50	102.42	100.07
130.55	225.40	222.84	170.87	170.27	169.61	169.48	102.26	99.98
131.05	226.60	223.20	170.83	170.24	169.56	169.43	102.15	99.93
131.55	227.28	223.54	170.80	170.24	169.56	169.31	102.09	99.34
132.05	227.48	223.51	170.82	170.28	169.61	169.47	102.08	100.11
132.55	227.59	223.64	170.89	170.28	169.67	169.51	102.23	99.99
133.05	183.11	223.03	170.88	170.28	169.60	169.45	102.41	99.98
133.55	215.55	221.08	170.81	170.27	169.60	169.46	102.08	99.89
134.05	225.95	222.19	170.83	170.29	169.66	169.55	102.13	100.11
134.55	226.94	222.34	170.86	170.23	169.59	169.42	102.41	100.01

135.05	226.51	222.45	170.74	170.16	169.59	169.41	101.99	99.85
135.55	226.38	222.34	170.70	170.15	169.59	169.39	102.01	99.86
136.05	226.28	222.15	170.78	170.17	169.68	169.43	102.12	100.03
136.55	172.95	215.59	171.05	170.38	169.75	169.43	103.00	99.99
137.05	214.97	217.49	170.89	170.28	169.70	169.43	102.52	99.96
137.55	224.33	220.30	170.64	170.13	169.58	169.25	102.27	99.79
138.05	226.16	221.61	170.59	170.06	169.58	169.25	102.00	99.86
138.55	226.93	222.20	170.50	169.99	169.52	169.25	101.67	99.84
139.05	172.94	218.00	170.75	170.14	169.58	169.27	102.42	100.00
139.55	206.71	217.88	170.63	170.09	169.58	169.33	101.98	99.86
140.05	223.07	220.63	170.66	170.07	169.58	169.28	102.32	99.84
140.55	225.75	222.16	170.63	170.09	169.60	169.30	101.88	99.89
141.05	226.33	222.82	170.58	170.05	169.57	169.30	101.68	99.86
141.55	226.26	223.02	170.52	170.05	169.48	169.21	101.84	99.85
142.05	226.92	223.43	170.54	169.91	169.57	169.32	101.63	99.89
142.55	195.65	222.77	170.60	170.07	169.57	169.28	102.12	99.90
143.05	224.90	222.47	170.47	170.04	169.57	169.30	101.80	99.86
143.55	226.67	223.06	170.56	170.04	169.50	169.34	101.74	99.90
144.05	226.82	223.00	170.60	170.10	169.61	169.32	102.05	99.92
144.55	227.02	223.26	170.57	170.03	169.58	169.31	101.70	99.94
145.05	226.73	222.97	170.55	170.04	169.54	169.33	101.88	99.80
145.55	226.95	223.30	170.46	169.97	169.52	169.27	101.53	99.80
146.05	176.72	221.08	170.62	170.03	169.51	169.22	102.57	99.84
146.55	195.39	218.09	170.61	170.05	169.56	169.29	101.94	99.83
147.05	222.12	221.06	170.57	170.09	169.60	169.31	102.15	99.85
147.55	225.23	222.37	170.45	169.91	169.42	169.13	101.50	99.53
148.05	225.74	222.78	170.52	170.02	169.57	169.39	101.78	99.97
148.55	225.97	222.96	170.49	170.02	169.53	169.26	101.62	99.88
149.04	172.99	219.10	170.74	170.13	169.59	169.30	102.43	100.07
149.55	208.15	218.06	170.61	170.06	169.55	169.28	101.84	99.85
150.05	222.70	220.89	170.49	170.06	169.55	169.25	101.97	99.81
150.55	224.94	222.32	170.53	170.01	169.52	169.27	101.66	99.82
151.05	225.30	222.70	170.51	170.01	169.54	169.21	101.78	99.83
151.55	225.55	223.06	170.48	170.01	169.52	169.27	101.61	100.02
152.05	225.41	222.99	170.49	169.99	169.52	169.24	101.74	99.99
152.55	225.55	223.42	170.42	169.92	169.47	169.25	101.43	99.88
153.05	224.89	223.35	170.44	169.85	169.47	169.24	101.60	99.91
153.55	225.03	223.46	170.41	169.92	169.47	169.24	101.52	99.92
154.05	224.70	223.50	170.35	169.85	169.44	169.22	101.25	100.06

154.55	224.14	223.44	170.36	169.85	169.46	169.22	101.27	100.01
155.05	223.68	223.34	170.37	169.89	169.42	169.22	101.33	99.98
155.55	223.46	223.43	170.32	169.87	169.44	169.21	101.36	99.79
156.05	223.01	223.43	170.34	169.84	169.44	169.21	101.26	99.86
156.55	222.61	223.59	170.34	169.84	169.42	169.23	101.21	99.94
157.05	172.20	217.13	170.59	170.02	169.55	169.21	101.95	99.98
157.55	211.56	217.65	170.45	169.93	169.48	169.23	101.57	99.90
158.05	222.41	220.43	170.44	169.91	169.45	169.07	101.49	99.24
158.55	224.13	221.61	170.36	169.88	169.46	169.25	101.50	100.12
159.05	224.88	222.15	170.44	169.93	169.54	169.29	101.49	100.26
159.55	224.69	222.27	170.45	169.95	169.54	169.21	101.54	99.96
160.05	224.56	222.36	170.31	169.84	169.43	169.20	101.24	99.83
160.55	223.01	221.77	170.42	169.90	169.47	169.20	101.45	99.96
161.05	224.80	222.13	170.39	169.88	169.45	169.22	101.45	100.01
161.55	225.00	222.44	170.44	169.99	169.58	169.24	101.44	100.11
162.05	224.93	222.44	170.41	169.90	169.47	169.26	101.47	100.02
162.55	224.78	222.71	170.34	169.85	169.44	169.20	101.24	99.98
163.05	172.71	216.71	170.61	170.03	169.53	169.22	102.04	100.07
163.55	212.26	217.12	170.48	169.94	169.49	169.24	101.64	100.04
164.05	172.69	215.93	170.66	170.05	169.55	169.22	102.26	100.11
164.54	213.33	217.50	170.57	170.03	169.55	169.28	101.92	99.95
165.05	223.66	220.03	170.54	170.04	169.53	169.33	101.66	99.85
165.55	225.27	220.98	170.52	170.00	169.55	169.33	101.72	99.98
166.05	225.72	221.57	170.50	169.98	169.53	169.24	101.73	99.95
166.55	226.13	222.18	170.43	169.93	169.48	169.25	101.47	99.86
167.05	225.85	222.27	170.42	169.88	169.37	169.00	101.40	99.23
167.55	225.89	222.56	170.31	169.84	169.41	169.23	101.21	100.03
168.05	180.27	217.10	170.60	170.10	169.59	169.36	101.95	100.22
168.55	217.85	218.67	170.56	170.02	169.56	169.29	101.84	99.85
169.05	224.04	220.48	170.44	169.95	169.49	169.21	101.60	99.78
169.55	224.92	221.16	170.40	169.90	169.45	169.22	101.61	99.77
170.05	225.57	221.77	170.37	169.87	169.41	169.18	101.26	99.91
170.55	225.30	221.88	170.39	169.88	169.43	169.22	101.56	100.01
171.05	225.71	222.26	170.41	169.88	169.47	169.24	101.39	99.84
171.55	225.32	222.12	170.41	169.87	169.44	169.20	101.40	99.85
172.04	225.45	222.35	170.39	169.91	169.47	169.24	101.42	99.81
172.55	225.32	222.21	170.37	169.87	169.44	169.19	101.37	99.86
173.05	225.14	222.40	170.37	169.76	169.44	169.19	101.33	99.78
173.55	224.95	222.46	170.34	169.85	169.44	169.17	101.31	99.90

174.05	225.07	222.89	170.27	169.82	169.39	169.13	101.04	99.64
174.55	172.77	218.96	170.54	169.98	169.44	169.17	102.30	99.89
175.05	185.20	215.95	170.49	169.95	169.44	169.21	101.67	99.88
175.55	172.84	215.47	170.67	169.98	169.52	169.23	102.21	99.89
176.05	188.32	215.43	170.53	169.97	169.48	169.23	101.75	99.83
176.55	221.12	218.15	170.65	170.11	169.59	169.28	102.11	99.83
177.05	224.78	219.75	170.62	170.11	169.57	169.27	102.05	99.92
177.55	226.00	220.79	170.58	170.17	169.57	169.30	101.82	99.84
178.05	226.17	220.93	170.51	169.99	169.49	169.23	101.91	99.77
178.55	226.62	221.56	170.48	169.79	169.41	168.96	101.61	98.96
179.05	226.70	221.83	170.37	169.88	169.41	169.25	101.38	100.00
179.55	174.69	220.22	170.58	169.99	169.51	169.22	102.41	100.04
180.05	185.08	216.66	170.48	169.92	169.38	169.09	101.70	99.61

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